Package ‘rmgarch’

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The rmgarch package

Description

The rmgarch provides a selection of multivariate GARCH models with methods for fitting, filtering, forecasting and simulation with additional support functions for working with the returned objects. At present, the Generalized Orthogonal GARCH using Independent Components Analysis (ICA) and Dynamic Conditional Correlation (with multivariate Normal, Laplace and Student distributions) models are fully implemented, with methods for spec, fit, filter, forecast, simulation, and rolling estimation and forecasting, as well as specialized functions to calculate and work with the weighted portfolio conditional density. The Copula-GARCH model is also implemented with the multivariate Normal and Student distributions, with dynamic (DCC) and static estimation of the correlation.

Details

The main package functionality, currently supports the GO-GARCH with ICA method, and is available through the gogarchspec, gogarchfit, gogarchfilter, gogarchforecast, gogarchsim and gogarchroll functions. The DCC with multivariate Normal, Laplace and Student distributions is also supported with the main functionality in dccspec, dccfit, dccfilter, dccforecast, dccsim and dccroll. The Normal and Student Copula-GARCH, with dynamic or static correlation, is implemented with the main functionality in cgarchspec, cgarchfit, cgarchfilter, and cgarchsim. Usual extractor and support methods for the multivariate GARCH models are documented in the class of the returned objects.

How to cite this package

Whenever using this package, please cite as

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cGARCHfilter-class

cGARCHfilter-class

Author(s)

Alexios Ghalanos

References


cGARCHfilter-class  class: Copula Filter Class

Description

The class is returned by calling the function `cgarchfilter`.

Slots

mfilter: Object of class "vector" Multivariate filter list.

model: Object of class "vector" Model specification list.
cGARCHfilter-class

Extends

Class "mGARCHfilter", directly. Class "GARCHfilter", by class "mGARCHfilter", distance 2. Class "rGARCH", by class "mGARCHfilter", distance 3.

Methods

**coef** signature(object = "cGARCHfilter"): The coefficient vector (see note).

**fitted** signature(object = "cGARCHfilter"): The conditional mean filtered data (xts object).

**likelihood** signature(object = "cGARCHfilter"): The joint likelihood.

**rcor** signature(object = "cGARCHfilter"): The conditional correlation array with third dimension labels the time index.

**rcov** signature(object = "cGARCHfilter"): The conditional covariance array with third dimension labels the time index.

**residuals** signature(object = "cGARCHfilter"): The model residuals (xts object).

**show** signature(object = "cGARCHfilter"): Summary.

**sigma** signature(object = "cGARCHfilter"): The model conditional sigma (xts object).

**rshape** signature(object = "cGARCHfilter"): The multivariate distribution shape parameter(s).

**rskew** signature(object = "cGARCHfilter"): The multivariate distribution skew parameter(s).

Note

The ‘coef’ method takes additional argument ‘type’ with valid values ‘garch’ for the garch parameters, ‘dcc’ for the second stage parameters and by default returns all the parameters in a named vector.

Author(s)

Alexios Ghalanos

References

Description

Method for creating a Copula-GARCH filter object.

Usage

```r
cgarchfilter(spec, data, out.sample = 0, filter.control = list(n.old = NULL),
             spd.control = list(lower = 0.1, upper = 0.9, type = "pwm", kernel = "epanech"),
             cluster = NULL, varcoef = NULL, realizedVol = NULL, ...)
```

Arguments

- `spec`: A `cGARCHspec` object created by calling `cgarchspec` with fixed parameters for
  the coefficients.
- `data`: A multivariate xts data object or one which can be coerced to such.
- `out.sample`: A positive integer indicating the number of periods before the last to keep for
  out of sample forecasting.
- `filter.control`: Control arguments passed to the filtering routine (see note below).
- `cluster`: A cluster object created by calling `makeCluster` from the parallel package. If
  it is not NULL, then this will be used for parallel estimation (remember to stop
  the cluster on completion).
- `spd.control`: If the spd transformation was chosen in the specification, the spd.control passes
  its arguments to the `spdfit` routine of the spd package.
- `varcoef`: If a VAR model was chosen, then this is the VAR coefficient matrix which must
  be supplied. No checks are done on its dimension or correctness so it is up to
  the user to perform the appropriate checks.
- `realizedVol`: Required xts matrix for the realGARCH model.
- `...`: 

Value

A `cGARCHFilter` object containing details of the Copula-GARCH filter and sharing most of the
methods of the `cGARCHfit` class.

Note

The 'n.old' option in the `filter.control` argument is key in replicating conditions of the original
fit. That is, if you want to filter a dataset consisting of an expanded dataset (versus the original used
in fitting), but want to use the same assumptions as the original dataset then the 'n.old' argument
denoting the original number of data points passed to the `cgarchfit` function must be provided.
This is then used to ensure that some calculations which make use of the full dataset (unconditional
starting values for the garch filtering, the dcc model and the copula transformation methods) only
use the first ‘n.old’ points thus replicating the original conditions making filtering appropriate for rolling 1-ahead forecasting. For extensive examples look in the ‘rmgarch.tests’ folder.

Author(s)

Alexios Ghalanos

cGARCHfit-class  class: Copula Fit Class

Description

The class is returned by calling the function cgarchfit.

Slots

mfit: Object of class "vector" Multivariate fit list.
model: Object of class "vector" Model specification list.

Extends

Class "mGARCHfit", directly. Class "GARCHfit", by class "mGARCHfit", distance 2. Class "rGARCH", by class "mGARCHfit", distance 3.

Methods

c coef signature(object = "cGARCHfit"): The coefficient vector (see note).

c fitted signature(object = "cGARCHfit"): The conditional mean fitted data (xts object).

c likelihood signature(object = "cGARCHfit"): The joint likelihood.

c rcor signature(object = "cGARCHfit"): The conditional correlation array with third dimension labels the time index. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

c rcov signature(object = "cGARCHfit"): The conditional covariance array with third dimension labels the time index. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

c rshape signature(object = "cGARCHfit"): The multivariate distribution shape parameter(s).

c rskew signature(object = "cGARCHfit"): The multivariate distribution skew parameter(s).

c residuals signature(object = "cGARCHfit"): The model residuals (xts object).

c show signature(object = "cGARCHfit"): Summary.

c sigma signature(object = "cGARCHfit"): The model conditional sigma (xts object).
Note

The ‘coef’ method takes additional argument ‘type’ with valid values ‘garch’ for the garch parameters, ‘dcc’ for the second stage parameters and by default returns all the parameters in a named vector.

Author(s)

Alexios Ghalanos

References


cgarchfit-methods function: Copula-GARCH Fit

Description

Method for creating a Copula-GARCH fit object.

Usage

cgarchfit(spec, data, spd.control = list(lower = 0.1, upper = 0.9, type = "pwm", kernel = "epanech"), fit.control = list(eval.se = TRUE, stationarity = TRUE, scale = FALSE), solver = "solnp", solver.control = list(), out.sample = 0, cluster = NULL, fit = NULL, VAR.fit = NULL, realizedVol = NULL,...)

Arguments

spec A cgARCHspec object created by calling cgarchspec.
data A multivariate xts data object or one which can be coerced to such.
out.sample A positive integer indicating the number of periods before the last to keep for out of sample forecasting.
solver Either “nlminb”, “solnp”, “gosolnp” or “lbfgs”. It can also optionally be a vector of length 2 with the first solver being used for the first stage univariate GARCH estimation (in which case the option of “hybrid” is also available).
solver.control Control arguments list passed to optimizer.
fit.control Control arguments passed to the fitting routine. The ‘eval.se’ option determines whether standard errors are calculated (see details below). The ‘scale’ option is for the first stage univariate GARCH fitting routine.
cluster A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).
**cgarchfit-methods**

- **fit** (optional) A previously estimated univariate `uGARCHmultifit` object (see details).
- **VAR.fit** (optional) A previously estimated VAR list returned from calling the `varxfit` function.
- **spd.control** If the spd transformation was chosen in the specification, the spd.control passes its arguments to the `spdfit` routine of the `spd` package.
- **realizedVol** Required xts matrix for the realGARCH model.

### Details

The Copula-GARCH models implemented can either be time-varying or DCC variety else static. The multivariate Normal and Student distributions are used in the construction of the copulas, and 3 transformation methods are available (parametric, semi-parametric, and empirical). For the semi-parametric case the ‘spd’ package of the author is available to download from CRAN and fits a Gaussian kernel in the interior and gpd distribution for the tails (see that package for more details). The static copula allows for the estimation of the correlation matrix either by Maximum Likelihood or the Kendall method for the multivariate Student.

Note that the ‘cgarchfit’ method will assign to the global environment the `uGARCHmultifit` once that is estimated in order to allow the routine to be restarted should something go wrong (it should show up as `.fitlist`).

### Value

A cGARCHfit Object containing details of the Copula-GARCH fit.

### Note

There is no check on the VAR.fit list passed to the method so particular care should be exercised so that the same data used in the fitting routine is also used in the VAR fit routine. This must have been called with the option postpad `constant`. The ability to pass this list of the pre-calculated VAR model is particularly useful when comparing different models (such as DCC GARCH, GO GARCH etc) using the same dataset and VAR method (i.e. the same first stage conditional mean filtration). Though the classical VAR estimation is very fast and may not require this extra step, the robust method is slow and therefore benefits from calculating this only once. For extensive examples look in the ‘rmgarch.tests’ folder.

### Author(s)

Alexios Ghalanos
class: Copula Simulation Class

Description
The class is returned by calling the function `cgarchsim`.

Slots
- `msim`: Object of class "vector" Multivariate simulation list.
- `model`: Object of class "vector" Model specification list.

Extends
Class "mGARCHsim", directly. Class "GARCHsim", by class "mGARCHsim", distance 2. Class "rGARCH", by class "mGARCHsim", distance 3.

Methods
- `fitted` signature(`object = "cGARCHsim"`): The simulated conditional returns matrix given. Takes optional argument “sim” indicating the simulation run to return (from the m.sim option of the `cgarchsim` method.
- `sigma` signature(`object = "cGARCHfit"`): The simulated conditional sigma matrix given. Takes optional argument “sim” indicating the simulation run to return (from the m.sim option of the `cgarchsim` method.
- `rcor` signature(`object = "cGARCHsim"`): The simulated conditional correlation array (for DCC type). Takes optional argument “sim” indicating the simulation run to return (from the m.sim option of the `cgarchsim` method. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.
- `rcov` signature(`object = "cGARCHsim"`): The simulated conditional covariance array. Takes optional argument “sim” indicating the simulation run to return (from the m.sim option of the `cgarchsim` method. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.
- `show` signature(`object = "cGARCHsim"`): Summary.

Author(s)
Alexios Ghalanos

References
**Description**

Method for creating a Copula-GARCH simulation object.

**Usage**

```r
cgarchsim(fit, n.sim = 1000, n.start = 0, m.sim = 1,
startMethod = c("unconditional", "sample"), presigma = NULL, prer residua ls = NULL,
prereturns = NULL, preR = NULL, preQ = NULL, preZ = NULL, rseed = NULL,
mexsimdata = NULL, vexsimdata = NULL, cluster = NULL, only.density = FALSE,
prerealized = NULL, ...)
```

**Arguments**

- `fit` A `cGARCHfit` object created by calling `cgarchfit`.
- `n.sim` The simulation horizon.
- `n.start` The burn-in sample.
- `m.sim` The number of simulations.
- `startMethod` Starting values for the simulation. Valid methods are ‘unconditional’ for the expected values given the density, and ‘sample’ for the ending values of the actual data from the fit object. This is mostly related to the univariate GARCH dynamics.
- `presigma` Allows the starting sigma values to be provided by the user for the univariate GARCH dynamics.
- `prereturns` Allows the starting return data to be provided by the user for the conditional mean simulation.
- `preresiduals` Allows the starting residuals to be provided by the user and used in the GARCH dynamics simulation.
- `preR` Allows the starting correlation to be provided by the user and mostly useful for the static copula.
- `preQ` Allows the starting ‘DCC-Q’ value to be provided by the user and though unnecessary for the first 1-ahead simulation using the “sample” option in the `startMethod`, this is key to obtaining a rolling n-ahead forecast type simulation (see details below).
- `preZ` Allows the starting transformed standardized residuals (used in the DCC model) to be provided by the user and though unnecessary for the first 1-ahead simulation using the “sample” option in the `startMethod`, this is key to obtaining a rolling n-ahead forecast type simulation (see details below).
- `rseed` Optional seeding value(s) for the random number generator. This should be of length equal to `m.sim`.
mexsimdata  A list (equal to the number of asset) of matrices of simulated external regressor-
in-mean data with row length equal to n.sim + n.start. If the fit object contains 
external regressors in the mean equation, this must be provided else will be 
assumed to be zero.

vexsimdata  A list (equal to the number of asset) of matrices of simulated external regressor-
in-variance data with row length equal to n.sim + n.start. If the fit object contains 
external regressors in the variance equation, this must be provided else will be 
assumed to be zero.

cluster    A cluster object created by calling makeCluster from the parallel package. If 
it is not NULL, then this will be used for parallel estimation (remember to stop 
the cluster on completion).

only.density Whether to return only the simulated returns (discrete time approximation to 
the multivariate density). This is sometimes useful in order to control memory 
management for large simulations not requiring any other information.

prerealized Allows the starting realized volatility values to be provided by the user for the 
univariate GARCH dynamics.

Details

Since there is no explicit forecasting routine, the user should use this method for incrementally 
building up n-ahead forecasts by simulating 1-ahead, obtaining the means of the returns, sigma, 
Rho etc and feeding them to the next round of simulation as starting values. The ‘rmgarch.tests’ 
folder contains specific examples which illustrate this particular point.

Value

A cgarchsim object containing details of the Copula-GARCH simulation.

Author(s)

Alexios Ghalanos

References

Genest, C., Ghoudi, K. and Rivest, L. A semiparametric estimation procedure of dependence pa-
rameters in multivariate families of distributions, 1995, Biometrika, 82, 543-552.
class: Copula Specification Class

Description

The class is returned by calling the function `cgarchspec`.

Slots

- `model`: Object of class "vector" The multivariate model specification
- `umodel`: Object of class "uGARCHmultispec" The univariate model specification.

Extends

Class "mGARCHspec", directly. Class "GARCHspec", by class "mGARCHspec", distance 2. Class "rGARCH", by class "mGARCHspec", distance 3.

Methods

- `show` signature(object = "cGARCHspec"): Summary.
- `setfixed<-` signature(object = "cGARCHspec", value = "vector"): Set fixed second stage parameters.
- `setstart<-` signature(object = "cGARCHspec", value = "vector"): Set starting second stage parameters.

Author(s)

Alexios Ghalanos

References

cgarchspec-methods

Function: Copula-GARCH Specification

Description

Method for creating a Copula-GARCH specification object prior to fitting.

Usage

cgarchspec(uspec, VAR = FALSE, robust = FALSE, lag = 1, lag.max = NULL,
lag.criterion = c("AIC", "HQ", "SC", "FPE"), external.regressors = NULL,
robust.control = list(gamma = 0.25, delta = 0.01, nc = 10, ns = 500),
dccOrder = c(1, 1), asymmetric = FALSE,
distribution.model = list(copula = c("mvnorm", "mvt"),
method = c("Kendall", "ML"), time.varying = FALSE,
transformation = c("parametric", "empirical", "spd")),
start.pars = list(), fixed.pars = list())

Arguments

uspec  A uGARCHmultispec object created by calling multispec on a list of univariate
        GARCH specifications.
VAR     Whether to fit a VAR model for the conditional mean.
robust  Whether to use the robust version of VAR.
lag     The VAR lag.
lag.max The maximum VAR lag to search for best fit.
lag.criterion The criterion to use for choosing the best lag when lag.max is not NULL.
external.regressors Allows for a matrix of common pre-lagged external regressors for the VAR op-
        tion.
robust.control The tuning parameters to the robust regression including the proportion to trim
        ("gamma"), the critical value for reweighted estimator ("delta"), the number of
        subsets ("ns") and the number of C-steps ("nc").
dccOrder The DCC autoregressive order.
asymmetric Whether to include an asymmetry term to the DCC model (thus estimating the
        aDCC).
distribution.model The Copula distribution model. Currently the multivariate Normal and Student
        Copula are supported.
time.varying Whether to fit a dynamic DCC Copula.
transformation The type of transformation to apply to the marginal innovations of the GARCH
        fitted models. Supported methods are parametric (Inference Function of Mar-
        gins), empirical (Pseudo ML), and Semi-Parametric using a kernel interior and
        GPD tails (via the ‘spd’ package).
**Function**

`cordist`

**Usage**

```r
cordist(R, distance = c("ma","ms","meda","meds","eigen","cmd"), n = 25,
        plot = TRUE, dates = NULL, title = NULL)
```

**Arguments**

- `R`: An array of correlations.
- `distance`: The measure to use to capture the change between 2 correlation matrices (see details).
- `n`: The distance between 2 correlation matrices.
- `plot`: Whether to create a heatmap plot of the result.
- `dates`: A POSIXct vector of dates to use for the heatmap (recommend to supply).
- `title`: Title for the heatmap plot.

**Details**

The transformation method allows for parametric (Inference-Functions for Margins), empirical (Pseudo-Likelihood) and semi-parametric (via the spd package).

When the Student Copula is jointly estimated with student margins having so that a common shape parameter is obtained, this results in the multivariate Student distribution. When estimating the Student Copula with disparate margins, a meta-student distribution is obtained. Additionally, the correlation parameter in the static Student Copula may be estimated either by Kendall’s tau transformation or Maximum Likelihood.

The robust option allows for a robust version of VAR based on the multivariate Least Trimmed Squares Estimator described in Croux and Joossens (2008).

**Value**

A `cGARCHspec` object containing details of the Copula-GARCH specification.

**Author(s)**

Alexios Ghalanos
Details

This function provides for a visualization of dynamic correlation distance between periods with a number of plausible measures including “ma” (mean absolute), “ms” (mean squared), “meda” (median absolute), “meds” (median squared) “eigen” (largest eigenvalue difference) and “cmd” (correlation matrix distance). See the references for more details.

Value

A symmetric matrix of the rolling distance measure for each period.

Author(s)

Alexios Ghalanos

References

**sigma** signature(object = "DCCfilter"): The filtered conditional sigma xts object.

**residuals** signature(object = "DCCfilter"): The filtered conditional mean residuals xts object.

**plot** signature(x = "DCCfilter", y = "missing"): Plot method, given additional arguments ‘series’ and ‘which’.

**infocriteria** signature(object = "DCCfilter"): Information criteria.

**rcor** signature(object = "DCCfilter"): The filtered dynamic conditional correlation array given additional argument ‘type’ (either “R” for the correlation else will return the “Q” matrix). The third dimension label of the array gives the time index (from which it is then possible to construct pairwise xts objects for example). A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

**rcov** signature(object = "DCCfilter"): The filtered dynamic conditional covariance array. The third dimension label of the array gives the time index (from which it is then possible to construct pairwise xts objects for example). A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

**show** signature(object = "DCCfilter"): Summary.

**nisurface** signature(object = "DCCfilter"): The news impact surface plot given additional arguments ‘type’ with either “cov” or “cor” (for the covariance and correlation news impact respectively), ‘pair’ denoting the asset pair (defaults to c(1,2)), ‘plot’ (logical) and ‘plot.type’ with a choice of either “surface” or “contour”.

**Note**

The ‘coef’ method takes additional argument ‘type’ with valid values ‘garch’ for the univariate garch parameters, ‘dcc’ for the second stage dcc parameters and by default returns all the parameters in a named vector.

**Author(s)**

Alexios Ghalanos

**References**

Usage

dccfilter(spec, data, out.sample = 0, filter.control = list(n.old = NULL),
cluster = NULL, varcoef = NULL, realizedVol = NULL, ...)

Arguments

spec A DCCspec object created by calling dccspec with fixed parameters for the co-
efficients.
data A multivariate data object of class xts, or one which can be coerced to such.
out.sample A positive integer indicating the number of periods before the last to keep for
out of sample forecasting.
filter.control Control arguments passed to the filtering routine (see note).
cluster A cluster object created by calling makeCluster from the parallel package. If
it is not NULL, then this will be used for parallel estimation (remember to stop
the cluster on completion).
varcoef If a VAR model was chosen, then this is the VAR coefficient matrix which must
be supplied. No checks are done on its dimension or correctness so it is up to
the user to perform the appropriate checks.
realizedVol Required xts matrix for the realGARCH model.
... Value

A DCCfilter object containing details of the DCC-GARCH filter.

Note

The ‘n.old’ option in the filter.control argument is key in replicating conditions of the original
fit. That is, if you want to filter a dataset consisting of an expanded dataset (versus the original used
in fitting), but want to use the same assumptions as the original dataset then the ‘n.old’ argument
denoting the original number of data points passed to the dccfit function must be provided. This is
then used to ensure that some calculations which make use of the full dataset (unconditional starting
values for the garch filtering and the dcc model) only use the first ‘n.old’ points thus replicating the
original conditions making filtering appropriate for rolling 1-ahead forecasting.
For extensive examples look in the ‘rmgarch.tests’ folder.

Author(s)

Alexios Ghalanos
class: DCC Fit Class

Description

The class is returned by calling the function `dccfit`.

Slots

- `mfit`: Object of class "vector" Multivariate filter list.
- `model`: Object of class "vector" Model specification list.

Extends

Class "mGARCHfit", directly. Class "GARCHfit", by class "mGARCHfit", distance 2. Class "rGARCH", by class "mGARCHfit", distance 3.

Methods

- `coef` signature(object = "DCCfit") The coefficient vector (see note).
- `likelihood` signature(object = "DCCfit"): The joint likelihood.
- `rshape` signature(object = "DCCfit"): The multivariate distribution shape parameter(s).
- `rskew` signature(object = "DCCfit"): The multivariate distribution skew parameter(s).
- `fitted` signature(object = "DCCfit"): The fitted conditional mean xts object.
- `sigma` signature(object = "DCCfit"): The fitted conditional GARCH sigma xts object.
- `residuals` signature(object = "DCCfit"): The fitted conditional mean residuals xts object.
- `plot` signature(x = "DCCfit", y = "missing"): Plot method, given additional arguments `series` and `which`.
- `infocriteria` signature(object = "DCCfit"): Information criteria.
- `rcor` signature(object = "DCCfit"): The fitted dynamic conditional correlation array given additional arguments 'type' (either "R" for the correlation else will return the Q matrix). The third dimension label of the array gives the time index (from which it is then possible to construct pairwise xts objects for example). The argument ‘output’ can be either “array” (default) or “matrix” in which case the array is flattened and the lower diagonal time varying values are returned (and if a date exists, then the returned object is of class xts).
- `rcov` signature(object = "DCCfit"): The fitted dynamic conditional covariance array. The third dimension label of the array gives the time index (from which it is then possible to construct pairwise xts objects for example). The argument ‘output’ can be either “array” (default) or “matrix” in which case the array is flattened and the lower and main diagonal time varying values are returned (and if a date exists, then the returned object is of class xts).
- `show` signature(object = "DCCfit"): Summary.
- `nisurface` signature(object = "DCCfit"): The news impact surface plot given additional arguments 'type' with either “cov” or “cor” (for the covariance and correlation news impact respectively), 'pair' (defaults to c(1,2)), ‘plot’ (logical) and ‘plot.type’ with a choice of either “surface” or “contour”.
Note

The ‘coef’ method takes additional argument ‘type’ with valid values ‘garch’ for the univariate garch parameters, ‘dcc’ for the second stage dcc parameters and by default returns all the parameters in a named vector.

Author(s)

Alexios Ghalanos

References


dccfit-methods

function: DCC-GARCH Fit

Description

Method for creating a DCC-GARCH fit object.

Usage

dccfit(spec, data, out.sample = 0, solver = "solnp", solver.control = list(), fit.control = list(eval.se = TRUE, stationarity = TRUE, scale = FALSE), cluster = NULL, fit = NULL, VAR.fit = NULL, realizedVol = NULL, ...)

Arguments

spec A DCCspec object created by calling dccspec.
data A multivariate data object of class xts or one which can be coerced to such.
out.sample A positive integer indicating the number of periods before the last to keep for out of sample forecasting.
solver Either “nlminb”, “solnp”, “gosolnp” or “lbfgs”. It can also optionally be a vector of length 2 with the first solver being used for the first stage univariate GARCH estimation (in which case the option of “hybrid” is also available).
solver.control Control arguments list passed to optimizer.
fit.control Control arguments passed to the fitting routine. The ‘eval.se’ option determines whether standard errors are calculated (see details below). The ‘stationarity’ option is for the univariate stage GARCH fitting routine, whilst for the second stage DCC this is imposed by design. The ‘scale’ option is also for the first stage univariate GARCH fitting routine.
cluster A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).
DCCforecast-class

fit (optional) A previously estimated univariate uGARCHmultifit object (see details).

VAR.fit (optional) A previously estimated VAR object returned from calling the varxfit function.

realizedVol Required xts matrix for the realGARCH model.

Details

The 2-step DCC estimation fits a GARCH-Normal model to the univariate data and then proceeds to estimate the second step based on the chosen multivariate distribution. Because of this 2-step approach, standard errors are expensive to calculate and therefore the use of parallel functionality, built into both the fitting and standard error calculation routines is key. The switch to turn off the calculation of standard errors through the ‘fit.control’ option could be quite useful in rolling estimation such as in the dccroll routine.

The optional ‘fit’ argument allows to pass your own uGARCHmultifit object instead of having the routine estimate it. This is very useful in cases of multiple use of the same fit and problems in convergence which might require a more hands on approach to the univariate fitting stage. However, it is up to the user to ensure consistency between the ‘fit’ and supplied ‘spec’.

Value

A DCCfit object containing details of the DCC-GARCH fit.

Note

There is no check on the VAR.fit list passed to the method so particular care should be exercised so that the same data used in the fitting routine is also used in the VAR fit routine. This must have been called with the option postpad ‘constant’. The ability to pass this list of the pre-calculated VAR model is particularly useful when comparing different models (such as copula-GARCH, GO-GARCH etc) using the same dataset and VAR method (i.e. the same first stage conditional mean filtration). Though the classical VAR estimation is very fast and may not require this extra step, the robust method is slow and therefore benefits from calculating this only once.

For extensive examples look in the ‘rmgarch.tests’ folder.

Author(s)

Alexios Ghalanos

DCCforecast-class  

Description

The class is returned by calling the function dccforecast.
Slots

- mforecast: Object of class "vector" Multivariate forecast list.
- model: Object of class "vector" Model specification list.

Extends

Class "mGARCHforecast", directly. Class "GARCHforecast", by class "mGARCHforecast", distance 2. Class "rGARCH", by class "mGARCHforecast", distance 3.

Methods

- rshape signature(object = "DCCforecast"): The multivariate distribution shape parameter(s).
- rskew signature(object = "DCCforecast"): The multivariate distribution skew parameter(s).
- fitted signature(object = "DCCforecast"): The conditional mean forecast array of dimensions n.ahead x n.assets by (n.roll+1). The thirds dimension of the array has the T+0 index label.
- sigma signature(object = "DCCforecast"): The conditional sigma forecast array of dimensions n.ahead x n.assets by (n.roll+1). The thirds dimension of the array has the T+0 index label.
- plot signature(x = "DCCforecast", y = "missing"): Plot method, given additional arguments ‘series’ and ‘which’.
- rcor signature(object = "DCCforecast"): The forecast dynamic conditional correlation list of arrays of length (n.roll+1), with each array of dimensions n.assets x n.assets x n.ahead. The method takes on one additional argument ‘type’ (either “R” for the correlation else will return the DCC Q matrix). A further argument ‘output’ allows to switch between “array” and “matrix” returned object.
- rcov signature(object = "DCCforecast"): The forecast dynamic conditional correlation list of arrays of length (n.roll+1), with each array of dimensions n.assets x n.assets x n.ahead. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.
- show signature(object = "DCCforecast"): Summary.

Author(s)

Alexios Ghalanos

References

Description
Method for creating a DCC-GARCH forecast object.

Usage

dccforecast(fit, n.ahead = 1, n.roll = 0,
external.forecasts = list(mregfor = NULL, vregfor = NULL), cluster = NULL, ...)

Arguments

fit
A DCCfit object created by calling dccfit.
n.ahead
The forecast horizon.
n.roll
The no. of rolling forecasts to create beyond the first one (see details).
external.forecasts
A list with forecasts for the external regressors in the mean and/or variance
equations if specified (see details).
cluster
A cluster object created by calling makeCluster from the parallel package. If
it is not NULL, then this will be used for parallel estimation (remember to stop
the cluster on completion).

Details
When using n.roll, it is assumed that dccfit was called with argument ‘out.sample’ being large
enough to cover n-rolling forecasts.
When n.roll = 0, all forecasts are based on an unconditional n-ahead forecast routine based on the
approximation method described in ENGLE and SHEPPARD (2001) paper (see reference below). If
any external regressors are present, then the user must pass in their unconditional forecasts in
the ‘external.forecasts’ list, as matrices with dimensions equal to n.ahead x n.assets. This assumes
that the univariate GARCH specifications share common external regressors (this may change in
the future).
When n.roll>0 and n.ahead = 1, then this is a pure rolling forecast based on the available out.sample
data provided for in the call to the fit routine. It is also assumed that if any external regressors were
passed to the fit routine that they contained enough values to cover the out.sample period so that
they could be used in this forecast scenario.
The case of n.roll > 0 AND n.ahead > 1 is not implemented.

Value
A DCCForecast object containing details of the DCC-GARCH forecast.
Author(s)
Alexios Ghalanos

References

DCCroll-class

class: DCC Roll Class

Description
The class is returned by calling the function dccroll.

Slots
mforecast: Object of class "vector" Multivariate forecast list.
model: Object of class "vector" Model specification list.

Extends
Class "mGARCHroll", directly. Class "GARCHroll", by class "mGARCHroll", distance 2. Class "rGARCH", by class "mGARCHroll", distance 3.

Methods

coeff signature(object = "DCCroll"): The coefficient array across the rolling estimations with a T+0 3rd dimension index label.
fitted signature(object = "DCCroll"): The conditional mean forecast xts object (with the actual T+i forecast dates as index).
likelihood signature(object = "DCCroll"): The log-likelihood across rolling estimations.
plot signature(x = "DCCroll", y = "missing"): Plot method, given additional arguments 'series' and 'which'.
rcor signature(object = "DCCroll"): The forecast dynamic conditional correlation array, with the T+i forecast index in the 3rd dimension label. Optional argument 'type' determines whether to return "R" for the correlation else will the DCC Q matrix. A further argument 'output' allows to switch between "array" and "matrix" returned object.
rcov signature(object = "DCCroll"): The forecast dynamic conditional covariance array, with the T+i forecast index in the 3rd dimension label. A further argument 'output' allows to switch between "array" and "matrix" returned object.
rshape signature(object = "DCCroll"): The multivariate distribution shape parameter(s).
rskew signature(object = "DCCroll"): The multivariate distribution skew parameter(s).
show signature(object = "DCCroll"): Summary.
sigma signature(object = "DCCroll"): The conditional sigma forecast xts object (with the actual T+i forecast dates as index).
dccroll-methods

Author(s)
Alexios Ghalanos

References

dccroll-methods  function: DCC-GARCH Rolling Forecast

Description
Method for creating a DCC-GARCH rolling forecast object.

Usage
dccroll(spec, data, n.ahead = 1, forecast.length = 50, refit.every = 25, n.start = NULL, refit.window = c("recursive", "moving"), window.size = NULL, solver = "solnp", solver.control = list(), fit.control = list(eval.se = TRUE, stationarity = TRUE, scale = FALSE), cluster = NULL, save.fit = FALSE, save.wdir = NULL, realizedVol = NULL, clusterOnAssets=FALSE, ...)

Arguments
spec     A `DCCspec` object with fixed parameters.
data     A multivariate xts dataset or one which can be coerced to such.
n.ahead  The number of periods to forecast.
forecast.length  The length of the total forecast for which out of sample data from the dataset will be used for testing.
n.start  Instead of forecast.length, this determines the starting point in the dataset from which to initialize the rolling forecast.
refit.every  Determines every how many periods the model is re-estimated.
refit.window  Whether the refit is done on an expanding window including all the previous data or a moving window where all previous data is used for the first estimation and then moved by a length equal to refit.every (unless the window.size option is used instead).
window.size  If not NULL, determines the size of the moving window in the rolling estimation, which also determines the first point used.
solver     The solver to use.
fit.control  Control parameters passed to the fitting function.
solver.control: Control parameters passed to the solver.

cluster: A cluster object created by calling `makeCluster` from the parallel package. If it
is not NULL, then this will be used for parallel estimation of the refits (remember
to stop the cluster on completion).

save.fit: Whether to save the fitted objects of class `DCCfit` during the estimation of each
(“refit.every”). If true, the directory to save must be provided. The function will
not save this by default for reasons of memory management, but can save it as
an “.rda” file in the user’s chosen directory for further analysis.

save.wdir: If “save.fit” is true, the directory in which to save the `DCCfit` objects (1 for each
“refit.every”).

realizedVol: Required xts matrix for the realGARCH model.

clusterOnAssets: If a cluster object is provided, use parallel resources on the univariate estimation
(TRUE) else on the rolling windows (FALSE).

Value

A `DCCroll` object containing details of the DCC-GARCH rolling forecast.

Author(s)

Alexios Ghalanos

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**DCCsim-class**

*class: DCC Forecast Class*

**Description**

The class is returned by calling the function `dccsim`.

**Slots**

- `msim`: Object of class "vector" Multivariate simulation list.
- `model`: Object of class "vector" Model specification list.

**Extends**

Class "mGARCHsim", directly. Class "GARCHsim", by class "mGARCHsim", distance 2. Class
"rGARCH", by class "mGARCHsim", distance 3.
### Methods

**fitted** signature(object = "DCCsim"): The conditional mean simulated data matrix given additional argument ‘sim’ denoting the simulation run (m.sim) to return values for.

**rcor** signature(object = "DCCsim"): The simulated dynamic conditional correlation array given additional arguments ‘sim’ denoting the simulation run (m.sim) to return values for, and ‘type’ (either “R” for the correlation else will return the Q matrix). A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

**rcov** signature(object = "DCCsim"): The simulated dynamic conditional covariance array given additional argument ‘sim’ denoting the simulation run (m.sim) to return values for. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

**sigma** signature(object = "DCCsim"): The univariate simulated conditional sigma matrix given additional argument ‘sim’ (m.sim) denoting the simulation run to return values for.

**show** signature(object = "DCCsim"): Summary.

### Author(s)

Alexios Ghalanos

### References


### dccsim-methods function: DCC-GARCH Simulation

#### Description

Method for creating a DCC-GARCH simulation object.

#### Usage

dccsim(fitORspec, n.sim = 1000, n.start = 0, m.sim = 1, startMethod = c("unconditional", "sample"), presigma = NULL, preresiduals = NULL, prereturns = NULL, preQ = NULL, preZ = NULL, Qbar = NULL, Nbar = NULL, rseed = NULL, mexsimdata = NULL, vexsimdata = NULL, cluster = NULL, VAR.fit = NULL, prerealized = NULL, ...)

#### Arguments

- **fitORspec**: A DCCspec or DCCfit object created by calling either dccspec with fixed parameters or dccfit.
- **n.sim**: The simulation horizon.
- **n.start**: The burn-in sample.
m.sim

The number of simulations.

startMethod

Starting values for the simulation. Valid methods are “unconditional” for the expected values given the density, and “sample” for the ending values of the actual data from the fit object (for the dispatch method using a specification, “sample” is not relevant).

presigma

Allows the starting sigma values to be provided by the user for the univariate GARCH dynamics.

prereturns

Allows the starting return data to be provided by the user for the conditional mean simulation.

preresiduals

Allows the starting residuals to be provided by the user and used in the GARCH dynamics simulation.

preQ

Allows the starting ‘DCC-Q’ value to be provided by the user and though unnecessary for the first 1-ahead simulation using the “sample” option in the startMethod, this is key to obtaining a rolling n-ahead forecast type simulation (see details below).

preZ

Allows the starting standardized residuals to be provided by the user and though unnecessary for the first 1-ahead simulation using the “sample” option in the startMethod, this is key to obtaining a rolling n-ahead forecast type simulation (see details below).

Qbar

The DCC dynamics unconditional Q matrix, required for the specification dispatch method.

Nbar

The aDCC dynamics unconditional asymmetry matrix, required for the specification dispatch method.

rseed

Optional seeding value(s) for the random number generator. For m.sim>1, it is possible to provide either a single seed to initialize all values, or one seed per separate simulation (i.e. m.sim seeds). However, in the latter case this may result in some slight overhead depending on how large m.sim is.

mexsimdata

A list (equal to the number of asset) of matrices of simulated external regressor-in-mean data with row length equal to n.sim + n.start. If the fit object contains external regressors in the mean equation, this must be provided else will be assumed to be zero.

vexsimdata

A list (equal to the number of asset) of matrices of simulated external regressor-in-variance data with row length equal to n.sim + n.start. If the fit object contains external regressors in the variance equation, this must be provided else will be assumed to be zero.

cluster

A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).

VAR.fit

An VAR.fit list returned from calling the varxfilter or varxfit function with postpad set to “constant”. This is required for the specification dispatch method.

prerealized

Allows the starting realized volatility values to be provided by the user for the univariate GARCH dynamics.

...
Details

In order to pass a correct specification to the filter routine, you must ensure that it contains the appropriate 'fixed.pars' in both the multivariate DCC part of the specification as well as the multiple univariate specification part, for which the method `setfixed<-` should be used.

Value

A `DCCsim` object containing details of the DCC-GARCH simulation.

Author(s)

Alexios Ghalanos

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**Description**

The class is returned by calling the function `dccspec`.

**Slots**

- `model`: Object of class "vector" The multivariate model specification list.
- `umodel`: Object of class "vector" The univariate model specification list.

**Extends**

Class "mGARCHspec", directly. Class "GARCHspec", by class "mGARCHspec", distance 2. Class "rGARCH", by class "mGARCHspec", distance 3.

**Methods**

- `setfixed<-` signature(object = "DCCspec", value = "vector"): Set fixed second stage parameters.
- `setstart<-` signature(object = "DCCspec", value = "vector"): Set starting second stage parameters.
- `show` signature(object = "DCCspec"): Summary.

**Note**

The ‘umodel’ list is absorbed into the ‘model’ list in all other DCC classes.

**Author(s)**

Alexios Ghalanos
References


dccspec-methods function: DCC-GARCH Specification

Description

Method for creating a DCC-GARCH specification object prior to fitting.

Usage

dccspec(uspec, VAR = FALSE, robust = FALSE, lag = 1, lag.max = NULL,
lag.criterion = c("AIC", "HQ", "SC", "FPE"), external.regressors = NULL,
robust.control = list("gamma" = 0.25, "delta" = 0.01, "nc" = 10, "ns" = 500),
dccOrder = c(1,1), model = c("DCC", "aDCC", "FDCC"), groups = rep(1, length(uspec@spec)),
distribution = c("mvnorm", "mvt", "mvlaplace"), start.pars = list(), fixed.pars = list())

Arguments

uspec A *uGARCHmultispec* object created by calling *multispec* on a list of univariate GARCH specifications.
VAR Whether to fit a VAR model for the conditional mean.
robust Whether to use the robust version of VAR.
lag The VAR lag.
lag.max The maximum VAR lag to search for best fit.
lag.criterion The criterion to use for choosing the best lag when lag.max is not NULL.
external.regressors Allows for a matrix of common pre-lagged external regressors for the VAR option.
robust.control The tuning parameters to the robust regression including the proportion to trim ("gamma"), the critical value for re-weighted estimator ("delta"), the number of subsets ("ns") and the number of C-steps ("nc").
dccOrder The DCC autoregressive order.
model The DCC model to use, with a choice of the symmetric DCC, asymmetric (aDCC) and the Flexible DCC (FDCC). See notes for more details.
groups The groups corresponding to each asset in the FDCC model, where these are assumed and checked to be contiguous and increasing (unless only 1 group).
distribution: The multivariate distribution. Currently the multivariate Normal, Student and Laplace are implemented, and only the Normal for the FDCC model.

start.pars: (optional) Starting values for the DCC parameters (starting values for the univariate garch specification should be passed directly via the ‘uspec’ object).

fixed.pars: (optional) Fixed DCC parameters. This is required in the dccfilter, dccforecast, dccsim with spec, and dccroll methods.

Details

The robust option allows for a robust version of VAR based on the multivariate Least Trimmed Squares Estimator described in Croux and Joossens (2008).

Value

A DCCspec object containing details of the DCC-GARCH specification.

Note

The FDCC model of Billio, Caporin and Gobbo (2006) allows different DCC parameters to govern the dynamics of the correlation of distinct groups. The drawback is a somewhat larger parameter set, and no correlation targeting. Still, it remains a feasible model for not too large a number of groups, and avoids the unrealistic assumption, particularly for large datasets, of one parameter governing all the dynamics, as in the DCC model. Note that the group indices must be increasing (unless all 1), which means that you should arrange your dataset so that the assets are ordered by their groups.

Author(s)

Alexios Ghalanos

References

DCCtest

Engle and Sheppard Test of Dynamic Correlation

Description

A test of non-constant correlation based on Engle and Sheppard (2001).

Usage

DCCtest(Data, garchOrder = c(1,1), n.lags = 1, solver = "solnp",
         solver.control = list(), cluster = NULL, Z = NULL)

Arguments

Data
A multivariate data matrix.

garchOrder
The first stage common GARCH order.

n.lags
The number of lags to test for the presence of non-constant correlation.

solver
Either “solnp” or “nlminb”.

solver.control
Control arguments list passed to optimizer.

cluster
A cluster object created by calling makeCluster from the parallel package. If
it is not NULL, then this will be used for parallel estimation (remember to stop
the cluster on completion).

Z
(Optional) The standardized residuals from a constant correlation model. If sup-
plied the model is not estimated since this is the only input the test requires.

Details

The test effectively equates to estimating a multivariate dataset using the Constant Conditional Cor-
relation (CCC) model of Bollerslev (1990) and after which the standardized residuals (standardized
by the symmetric square root decomposition of the estimated constant correlation matrix) should
be i.i.d. with covariance the identity matrix. Testing for this can be done using a series of artifi-
cial regressions on the outer and lagged product of these residuals and a constant. In the rmgarch
package, the CCC model is calculated using a static GARCH copula (Normal) model.

Value

A list with the proposed Null hypothesis (H0), the test statistic and its p-value.

Author(s)

Alexios Ghalanos
References
Bollerslev, T. 1990, Modelling the coherence in short-run nominal exchange rates: a multivariate
Engle, R.F. and Sheppard, K. 2001, Theoretical and empirical properties of dynamic conditional

dji30retw  data: Dow Jones 30 Constituents Closing Value log Weekly Return

Description
Dow Jones 30 Constituents closing value weekly (Friday) log returns from 1987-03-16 to 2009-
02-03 from Yahoo Finance. Note that AIG was replaced by KFT (Kraft Foods) on September 22,
2008. This is not reflected in this data set as that would bring the starting date of the data to 2001.
When data was not available for a Friday, the closest previous close for which data was available
was used.

Usage
data(dji30retw)

Format
A data.frame containing 30x1141 observations.

Source
Yahoo Finance

fastica  Fast Fixed Point ICA

Description
The fast fixed point algorithm for independent component analysis and projection pursuit based on
the direct translation to R of the FastICA program of the original authors at the Helsinki University
of Technology.

Usage
fastica(X, approach = c("symmetric", "deflation"), n.comp = dim(X)[2], demean = TRUE,
pca.cov = c("ML", "LW", "ROB", "EWMA"), gfun = c("pow3", "tanh", "gauss", "skew"),
finetune = c("none", "pow3", "tanh", "gauss", "skew"), tanh.par = 1, gauss.par = 1,
step.size = 1, stabilization = FALSE, epsilon = 1e-4, maxiter1 = 1000, maxiter2 = 5,
A.init = NULL, pct.sample = 1, firstEig = NULL, lastEig = NULL,
 pcaE = NULL, pcaD = NULL, whiteSig = NULL, whiteMat = NULL, dewhiteMat = NULL,
rseed = NULL, trace = FALSE, ...)
Arguments

X  The multidimensional signal matrix, where each column of matrix represents one observed signal.

approach  The decorrelation approach to use, with “symmetric” estimating the components in parallel while “deflation” estimating one-by-one as in projection pursuit.

n.comp  Number of independent components to estimate, defaults to the dimension of the data (rows). Is overwritten by firstEig and lastEig.

demean  (Logical) Whether the data should be centered.

pca.cov  The method to use for the calculation of the covariance matrix during the PCA whitening phase. “ML” is the standard maximum likelihood method, “LW” is the Ledoit and Wolf method, “ROB” is the robust method from the MASS package and “EWMA” an exponentially weighted moving average estimator. Optional parameters passed via the (...) argument.

gfun  The nonlinearity algorithm to use in the fixed-point algorithm.

finetune  The nonlinearity algorithm for fine-tuning.

tanh.par  Control parameter used when nonlinearity algorithm equals “tanh”.

gauss.par  Control parameter used when nonlinearity algorithm equals “gauss”.

step.size  Step size. If this is anything other than 1, the program will use the stabilized version of the algorithm.

stabilization  Controls whether the program uses the stabilized version of the algorithm. If the stabilization is on, then the value of step.size can momentarily be halved if the program estimates that the algorithm is stuck between two points (this is called a stroke). Also if there is no convergence before half of the maximum number of iterations has been reached then the step.size will be halved for the rest of the rounds.

epsilon  Stopping criterion. Default is 0.0001.

maxiter1  Maximum number of iterations for gfun algorithm.

maxiter2  Maximum number of iterations for finetune algorithm.

A.init  Initial guess for the mixing matrix A. Defaults to a random (standard normal) filled matrix (no.signals by no.factors).

pct.sample  Percentage [0-1] of samples used in one iteration. Samples are chosen at random.

firstEig  This and lastEig specify the range for eigenvalues that are retained, firstEig is the index of largest eigenvalue to be retained. Making use of this option overwrites n.comp.

lastEig  This is the index of the last (smallest) eigenvalue to be retained and overwrites n.comp argument.

pcaE  Optionally provided eigenvector (must also supply pcaD).

pcaD  Optionally provided eigenvalues (must also supply pcaE).

whitesig  Optionally provided Whitened signal.

whitemat  Optionally provided Whitening matrix (no.factors by no.signals).
### fastica

**dewhiteMat**  Optionally provided dewhitenning matrix (no.signals by no.factors).

**rseed**  Optionally provided seed to initialize the mixing matrix A (when A.init not provided).

**trace**  To report progress in the console, set this to ‘TRUE’.

**...**  Optional arguments passed to the pca.cov methods.

### Details

The fastica program is a direct translation into R of the FastICA Matlab program of Gaevert, Hurri, Saerelae, and Hyvaerinen with some extra features. All computations are currently implemented in R so for very large dimensional sets alternative implementations may be faster. Porting part of the code to C++ may be implemented in a future version.

### Value

A list containing the following values:

- **A**  Estimated Mixing Matrix (no.signals by no.factors).
- **W**  Estimated UnMixing Matrix (no.factors by no.signals).
- **U**  Estimated rotation Matrix (no.factors by no.factors).
- **S**  The column vectors of estimated independent components (no.obs by no.factors).
- **C**  Estimated Covariance Matrix (no.signals by no.signals).
- **whiteningMatrix**  The Whitening matrix (no.factors by no.signals).
- **dewhitenningMatrix**  The de-Whitening matrix (no.signals by no.factors).
- **rseed**  The random seed used (if any) for initializing the mixing matrix A.
- **elapsed**  The elapsed time.

### Note

Since version 1.0-3 the multidimensional signal matrix is now the usual row by column matrix, where the rows represent observations and columns the signals. Before this version, the reverse was true in keeping with the original version of the program.

Dimensionality reduction can be achieved in the PCA stage by use of either **n.comp** in which case the n.comp largest eigenvalues are chosen, else by selection of **firstEig** and **lastEig** which overwrites the choice of n.comp.

### Author(s)

Hugo Gaevert, Jarmo Hurri, Jaakko Saerelae, and Aapo Hyvaerinen for the original FastICA package for matlab.
Alexios Ghalanos for this R-port.
References


Examples

```r
## Not run:
# create a set of independent signals S, glued together by a mixing matrix A
# (note the notation and matrix multiplication direction as we are dealing with
# row rather than column vectors)
set.seed(100)
S <- matrix(rnorm(10000), 5000, 2)
A <- matrix(c(1, 1, -1, 2), 2, 2, byrow = TRUE)
# the mixed signal X
X = S %*% t(A)
# The function centers and whitens (by the eigenvalue decomposition of the
# unconditional covariance matrix) the data before applying the theICA algorithm.
IC <- fastica(X, n.comp = 2, approach = "symmetric", gfun = "tanh", trace = TRUE, A.init = diag(2))

# demeaned data:
X_bar = scale(X, scale = FALSE)

# whitened data:
X_white = X_bar %*% t(IC$whiteningMatrix)

# check whitening:
# check correlations are zero
cor(X_white)
# check diagonals are 1 in covariance
cov(X_white)

# check that the estimated signals(S) multiplied by the
# estimated mixing matrix (A) are the same as the original dataset (X)
round(head(IC$ %*% t(IC$A)), 12) == round(head(X), 12)

# do some plots:
par(mfrow = c(1, 3))
plot(IC$ %*% t(IC$A), main = "Pre-processed data")
plot(X_white, main = "Whitened and Centered components")
plot(IC$, main = "ICA components")

## End(Not run)
```
Description

Object returned from calling `fmoments`.

Objects from the Class

Objects can be created by calls of the form `new("fMoments", ...).

Slots

moments: Object of class "vector" A list with the (roll+1) n-ahead forecast moment matrices.
model: Object of class "vector" A list with details of data generating process.

Methods

`show` signature(object = "fMoments"): Summary method.
`fitted` signature(object = "fMoments"): Conditional mean forecast matrix.
`rcov` signature(object = "fMoments"): Conditional covariance forecast array.
`rcoskew` signature(object = "fMoments"): Conditional third co-moment array.
`rcokurt` signature(object = "fMoments"): Conditional fourth co-moment array.

Author(s)

Alexios Ghalanos

Examples

`showClass("fMoments")`

---

Description

Generates n-ahead forecast moment matrices given a choice of data generating processes.

Usage

`fmoments(spec, Data, n.ahead = 1, roll = 0, solver = "solnp", solver.control = list(), fit.control = list(eval.se = FALSE), cluster = NULL, save.output = FALSE, save.dir = getwd(), save.name = paste("M", sample(1:1000, 1), sep = ""), ...)"`
Arguments

Data  An n-by-m data matrix or data.frame.
spec  Either a DCCspec or GOGARCHspec.
n.ahead The n.ahead forecasts (n.ahead>1 is unconditional).
roll  Whether to fit the data using (n - roll) periods and then return a (roll+1) n-ahead rolling forecast moments.
solver  The choice of solver to use for all models but “var”, and includes ‘solnp’, ‘nlminb’ and ‘nloptr’.
solver.control  Optional control options passed to the appropriate solver chosen.
fit.control  Control arguments passed to the fitting routine.
cluster  A cluster object created by calling `makeCluster` from the parallel package. If it is not NULL, then this will be used for parallel estimation of the refits (remember to stop the cluster on completion).
save.output  Whether output should be saved to file instead of being returned to the workspace.
save.dir  The directory to save output if save.output is TRUE.
save.name  The name of the file to save the output list.
...  Additional parameters passed to the model fitting routines. In particular, for the ‘gogarch’ model additional parameters are passed to the ICA routines, whereas for the ‘dcc’ and ‘cgarch’ models this would include the ‘realizedVol’ xts matrix for the realGARCH model.

Details

The function allows to generate forecast covariance matrices for use in the QP based EV model, and also for the “gogarch” model higher co-moment matrices for use in the Utility maximization model implemented separately.

Value

A `fMoments` object containing the forecast moments (list of length roll+1) and the model details (list).

Author(s)

Alexios Ghalanos
fScenario-class

Class "fScenario"

Description

Object returned from calling \texttt{fscenario}.

Objects from the Class

Objects can be created by calls of the form \texttt{new("fScenario", ...)}.

Slots

- \texttt{scenario}: Object of class "vector" A list with the (roll+1) scenario matrices.
- \texttt{model}: Object of class "vector" A list with details of data generating process.

Methods

- \texttt{show} signature(\texttt{object = "fScenario"}): Summary method.
- \texttt{goget} signature(\texttt{object = "fScenario"}): Get a specified 'arg' from the object (only 'scenario' used).
- \texttt{fitted} signature(\texttt{object = "fScenario"}): Returns an array of the simulated scenario returns, of dimensions n.sim by n.assets by (roll+1), with third dimension labels the actual forecast time index, and second dimension labels the asset names. The last forecast scenario will always be completely out of sample so the time index label for that is generated using the \texttt{generatefwd} function in the rugarch package.

Author(s)

Alexios Ghalanos

fscenario-methods

\textit{Scenario Generation}

Description

Generates a 1-ahead forecast scenario given a choice of data generating processes (for use in stochastic programming or risk management).
Usage

```r
fscenario(Data, sim = 1000, roll = 0,
model = c("gogarch", "dcc", "cgarch", "var", "mdist"),
spec = NULL,
var.model = list(lag = 1, lag.max = NULL,
lag.criterion = c("AIC", "HQ", "SC", "FPE"),
robust = FALSE, robust.control = list("gamma" = 0.25,
"delta" = 0.01, "nc" = 10, "ns" = 500)),
mdist.model = list(distribution = c("mvn", "mvt", "manig"),
AR = TRUE, lag = 1),
spd.control = list(lower = 0.1, upper = 0.9, type = "pwm",
kernel = "epanech"),
cov.method = c("ML", "LW", "EWMA", "MVE", "MCD", "MVT", "BS"),
cov.options = list(shrinkage=-1, lambda = 0.96),
solver = "solnp", solver.control = list(),
fit.control = list(eval.se = FALSE),
cluster = NULL, save.output = FALSE, save.dir = getwd(),
save.name = paste("S", sample(1:1000, 1), sep = ""), rseed = NULL, ...)
```

Arguments

- **Data**: An n-by-m data matrix or data.frame.
- **sim**: The size of the simulated 1-ahead forecast.
- **roll**: Whether to fit the data using (n - roll) periods and then return a (roll+1) 1-ahead rolling simulated scenarios.
- **model**: A choice of 5 models for generating scenarios.
- **spec**: Required if choosing 'gogarch', 'dcc' or 'cgarch', in which case this represents a specification object (see rmgarch package).
- **var.model**: Required if model is var.
- **mdist.model**: Required if model is mdist, and provides details for the model estimation (not yet implemented).
- **spd.control**: Required if model is “cgarch” and transformation is spd.
- **cov.method**: For model “var” this represents the choice of covariance matrix to use to generate random deviates.
- **cov.options**: For model “var” this provides the optional parameters to certain types of covariance estimation methods.
- **solver**: The choice of solver to use for all models but “var”, and includes ‘solnp’, ‘nlminb’ and ‘nloptr’.
- **solver.control**: Optional control options passed to the appropriate solver chosen.
- **fit.control**: Control arguments passed to the fitting routine.
- **cluster**: A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation of the refits (remember to stop the cluster on completion).
- **save.output**: Whether output should be saved to file instead of being returned to the workspace.
save.dir  The directory to save output if save.output is TRUE.
save.name  The name of the file to save the output list.
rseed  A vector of length sim to initiate the random number generator.

Details

The functionality here provides some wrapper functions, to create 1-ahead (and optionally rolling, useful for backtesting) scenarios for use in portfolio optimization using stochastic programming methods. The nature of these data generating processes (as implemented here) and resulting optimization problems results in the so called anticipative class of stochastic programming models. If save.output is chosen, and given a save.dir, the scenario is saved (using save.name) and an object is returned containing an empty list for the scenario but with a model details list and the seed values. This can then be passed on to the goload function which can read from the directory and return a complete object with the scenario.

Value

A \texttt{fScenario} object containing the scenario and the model details (list). The scenario list contains a list of the (roll+1) simulated forecast scenarios, the list of (roll+1) simulated forecast residuals, the forecast conditional mean, the forecast covariance and the list of random generator seed values used for replication. In addition, for the gogarch model the ICA whitening (K) and rotation matrices are also returned and required for replication of results (these may be entered in the \texttt{gogarchspec} function). Use the \texttt{fitted} method on the object to extract the simulated returns forecast.

Author(s)

Alexios Ghalanos

Description

Class for the GO-GARCH portfolio density

Objects from the Class

The class is returned by calling the function \texttt{convolution} on objects of class \texttt{goGARCHfit, goGARCHfilter, goGARCHforecast, goGARCHsim} and \texttt{goGARCHroll}

Slots

dist: A list with the portfolio density and other details.
model: A list with the model details carried across objects.
Methods

dfft signature(object = "goGARCHfft"): The takes additional argument “index” to indicate the particular time point, and returns an interpolated density function which may be called like any other “d” type density function.

pfft signature(object = "goGARCHfft"): The takes additional argument “index” to indicate the particular time point, and returns an interpolated distribution function which may be called like any other “p” type distribution function.

qfft signature(object = "goGARCHfft"): This takes additional argument “index” to indicate the particular time point, and returns an interpolated quantile function which may be called like any other “q” type quantile function. This may also be used to generate pseudo-random variables from the distribution by using random standard uniform numbers as inputs.

nportmoments signature(object = "goGARCHfft"): Calculate and returns a matrix of the first 4 standardized moments by evaluation of the portfolio density using quadrature based method (i.e. calling R’s “integrate” function on the portfolio FFT based density). Depending on the GOGARCH class the density was based (e.g. goGARCHfit vs goGARCHforecast), the format of the output will be different, and generally follow the format ‘rules’ of that class.

notes
In the case that convolution was called on a goGARCHforecast or goGARCHroll object, the dist slot will contain the max of n.ahead or n.roll. There should be no confusion here since the multivariate forecast methods in rmgarch only allow either n.ahead>1 with n.roll = 0 (pure unconditional), or n.ahead = 1 with n.roll>=0 (pure rolling), and only the latter in the case of a gogarchroll. While the nportmoments method reconstitutes the forecasts into a more familiar form (n.ahead x n.moments x (n.roll+1)), this does not make sense for the distribution methods (d*, p*, and q*), and it is understood that when the user calls for example dfft(object, index=5) on an object created from a forecast with n.ahead=10 and n.roll=0, the index is meant to indicate the unconditional density forecast at time T+5. Similarly, when calling codedfft(object, index=0) on an object created from a forecast with n.ahead=1 and n.roll = 1 (remember that n.roll is zero based), the index is meant to indicate the first (of two, since rolls = 0:1) rolling forecast density.

Author(s)
Alexios Ghalanos

goGARCHfilter-class  class: GO-GARCH Filter Class

Description
Class for the GO-GARCH filtered object.

Objects from the Class
The class is returned by calling the function gogarchfilter and is mainly called by gogarchfit when the “out.sample” option is used.
goGARCHfilter-class

Slots

mfilter: Multivariate filter object.
model: Object of class "vector" containing details of the GOGARCH model specification.

Extends

Class "mGARCHfilter", directly. Class "GARCHfilter", by class "mGARCHfilter", distance 2. Class "rGARCH", by class "mGARCHfilter", distance 3.

Methods

as.matrix signature(x = "goGARCHfilter"): function:
  as.matrix(x, which = "A")
  This returns four types of matrices relating to the estimation of the independent components
  in the GO-GARCH model. Valid choices are "A" for the mixing matrix, "W" for the unmixing
  matrix, "U" for the rotational matrix and "K" for the whitening matrix, "Kinv" for the de-
  whitening matrix.

likelihood signature(object = "goGARCHfilter"): The quasi log-likelihood of the model,
which being an independent factor model is the sum of the univariate GARCH log-likelihoods
plus a term for the mixing matrix. For a dimensionality reduced system, this is NA.

coef signature(object = "goGARCHfilter"): Extraction of independent factor GARCH model
coefficients.

fitted signature(object = "goGARCHfilter"): Extracts the conditional mean equation filtered
values.

residuals signature(object = "goGARCHfilter"): Extracts the conditional mean equation
residuals.

convolution signature(object = "goGARCHfilter"): function:
  convolution(object, weights, fft.step = 0.001, fft.by = 0.0001, fft.support = c(-1, 1), sup-
  port.method = c("user", "adaptive"), use.ff = TRUE, cluster = NULL, trace = 0,...)
  The convolution method takes a goGARCHfit object and a weights vector or matrix and cal-
  culates the weighted density. If a vector is given, it must be the same length as the number
  of assets, otherwise a matrix with row dimension equal to the row dimension of the filtered
dataset (i.e. less any lags). In the case of the multivariate normal distribution, this simply
returns the linear and quadratic transformation of the mean and covariance matrix, while in
the multivariate affine NIG distribution this is based on the numerical inversion by FFT of
the characteristic function. In that case, the “fft.step” option determines the stepsize for tun-
ing the characteristic function inversion, “fft.by” determines the resolution for the equally
spaced support given by “fft.support”, while the use of the “if” package is recommended to
avoid memory problems on some systems and is turned on via the “use.ff” option. The “sup-
port.method” option allows either a fixed support range to be given (option ‘user’), else an
adaptive method is used based on the min and max of the assets at each point in time at the
0.00001 and 1-0.00001 quantiles. The range is equally spaced subject to the “fft.by” value but
the returned object no longer makes of the “if” package returning instead a list. Finally, the
option for parallel computation is available via the use of a cluster object as elsewhere in this
package.
nisurface signature(object = "goGARCHfilter"): function:
nisurface(object, type = "cov", pair = c(1, 2), factor = c(1, 2), plot = TRUE)

Creates the covariance or correlation (determined by "type" being either "cov" or "cor") news impact surface for a pair of assets and factors. Since the shocks impact the factors independently, the news impact surface is a combination of the independent news impact curves of the factors which when combined via the mixing matrix $A$, create the dynamics for the underlying asset-factor surface function.

portmoments signature(object = "goGARCHfilter"): function:
gportmoments(object, weights)
Calculates the first 4 portfolio moments using the geometric properties of the model, given a vector or matrix of asset weights. If a matrix is given it must have row dimension equal to the row dimension of the filtered dataset (i.e. less any lags), else if a vector is given it will be replicated for all time points.

rcoskew signature(object = "goGARCHfilter") function:
rcoskew(object, standardize = TRUE, from = 1, to = 1)

Returns the 'time-varying' $N \times N^2$ coskewness tensor in array format. The “from” and “to” options indicate the time indices for which to return the arrays. Because of memory issues, this is limited to $100$ indices per call.

rcokurt signature(object = "goGARCHfilter") function:
rcokurt(object, standardize = TRUE, from = 1, to = 1)

Returns the 'time-varying' $N \times N^3$ cokurtosis tensor in array format. The “from” and “to” options indicate the time indices for which to return the arrays. Because of memory issues, this is limited to models with less than $100$ assets.

rcov signature(object = "goGARCHfilter"): Returns the time-varying $N \times N$ covariance matrix in array format. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

rcor signature(object = "goGARCHfilter"): Returns the time-varying $N \times N$ correlation matrix in array format. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

betacovar signature(object = "goGARCHfilter"): function:
betacovar(object, weights, asset = 1, cluster = NULL)

Returns the covariance beta given a matrix (of length equal to the number of rows of the original data, or vector which is then recycled to the number of rows of the original data) of benchmark weights and the asset number.

betacoskew signature(object = "goGARCHfilter"): function:
betacoskew(object, weights, asset = 1, cluster = NULL)

Returns the coskewness beta given a matrix (of length equal to the number of rows of the original data, or vector which is then recycled to the number of rows of the original data) of benchmark weights and the asset number.

betacokurt signature(object = "goGARCHfilter"): function:
betacokurt(object, weights, asset = 1, cluster = NULL)

Returns the cokurtosis beta given a matrix (of length equal to the number of rows of the original data, or vector which is then recycled to the number of rows of the original data) of benchmark weights and the asset number.

show signature(object = "goGARCHfilter"): Summary method.
Note
The reference by Paolella (2007) contains more details on the algorithm for the characteristic function inversion via FFT. The application of this method in a related model can be found in Chen (2007). The de Athayde and Flores (2002) paper is the basis for the geometric properties of the higher moment tensors in finance.

Author(s)
Alexios Ghalanos

References

gogarchfilter-methods  function: GO-GARCH Filter

Description
Method for filtering the GO-GARCH model.

Usage
gogarchfilter(fit, data, out.sample = 0, n.old = NULL, cluster = NULL, ...)

Arguments

fit  A GO-GARCH fit object of class goGARCHfit.
data  A multivariate data object. Can be a matrix or data.frame or timeSeries.
out.sample  A positive integer indicating the number of periods before the last to keep for out of sample forecasting.
n.old  For comparison with goGARCHfit models using the out.sample argument, this is the length of the original dataset.
cluster  A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).
...
Value
A `goGARCHfilter` object containing details of the GO-GARCH filter.

Author(s)
Alexios Ghalanos

Examples
```r
## Not run:
data(dji30ret)
spec = gogarchspec()
fit = gogarchfit(spec = spec, data = dji30ret[,1:4], gfun = "tanh")
filter = gogarchfilter(fit, data = dji30ret[,1:4])
## End(Not run)
```

Description
Class for the GO-GARCH fitted object.

Objects from the Class
The class is returned by calling the function `gogarchfit`.

Slots
- `mfit`: Multivariate fit object.
- `model`: Object of class "vector" containing details of the GO-GARCH model specification.

Extends
Class "mGARCHfit", directly. Class "GARCHfit", by class "mGARCHfit", distance 2. Class "rGARCH", by class "mGARCHfit", distance 3.

Methods
- `as.matrix` signature(x = "goGARCHfit"): function:
  ```r
  as.matrix(x, which = "A")
  ```
  This returns four types of matrices relating to the estimation of the independent components in the GO-GARCH model. Valid choices are "A" for the mixing matrix, "W" for the unmixing matrix, "U" for the rotational matrix and "K" for the whitening matrix, "Kinv" for the de-whitening matrix.
- `coef` signature(object = "goGARCHfit"): extraction of independent factor GARCH model coefficients.
convolution signature(object = "goGARCHfit"): function:
convolution(object, weights, fft.step = 0.001, fft.by = 0.0001, fft.support = c(-1, 1), support.method = c("user", "adaptive"), use.ff = TRUE, cluster = NULL, trace = 0,...)
The convolution method takes a goGARCHfit object and a weights vector or matrix and calculates the weighted density. If a vector is given, it must be the same length as the number of assets, otherwise a matrix with row dimension equal to the row dimension of the filtered dataset (i.e. less any lags). In the case of the multivariate normal distribution, this simply returns the linear and quadratic transformation of the mean and covariance matrix, while in the multivariate affine NIG distribution this is based on the numerical inversion by FFT of the characteristic function. In that case, the “fft.step” option determines the stepszie for tuning the characteristic function inversion, “fft.by” determines the resolution for the equally spaced support given by “fft.support”, while the use of the “ff” package is recommended to avoid memory problems on some systems and is turned on via the “use.ff” option. The “support.method” option allows either a fixed support range to be given (option ‘user’), else an adaptive method is used based on the min and max of the assets at each point in time at the 0.00001 and 1-0.00001 quantiles. The range is equally spaced subject to the “fft.by” value but the returned object no longer makes of the “ff” package returning instead a list. Finally, the option for parallel computation is available via the use of a cluster object as elsewhere in this package.

fitted signature(object = "goGARCHfit"): Extracts the conditional mean equation fitted values.

residuals signature(object = "goGARCHfit"): Extracts the conditional mean equation residuals.

likelihood signature(object = "goGARCHfit"): The quasi log-likelihood of the model, which being an independent factor model is the sum of the univariate GARCH log-likelihoods plus a term for the mixing matrix. For a dimensionality reduced system, this is NA.

nisurface signature(object = "goGARCHfit"): function:
nisurface(object, type = "cov", pair = c(1, 2), factor = c(1,2), plot = TRUE)
Creates the covariance or correlation (determined by “type” being either “cov” or “cor”) news impact surface for a pair of assets and factors. Since the shocks impact the factors independently, the news impact surface is a combination of the independent news impact curves of the factors which when combined via the mixing matrix A, create the dynamics for the underlying asset-factor surface function.

gportmoments signature(object = "goGARCHfit"): function:
gportmoments(object, weights)
Calculates the first 4 portfolio moments using the geometric properties of the model, given a vector or matrix of asset weights. If a matrix is given it must have row dimension equal to the row dimension of the filtered dataset (i.e. less any lags), else if a vector is given it will be replicated for all time points.

rcoskew signature(object = "goGARCHfit") function:
rcoskew(object, standardize = TRUE, from = 1, to = 1)
Returns the ‘time-varying’ NxN^2 coskewness tensor in array format. The “from” and “to” options indicate the time indices for which to return the arrays. Because of memory issues, this is limited to 100 indices per call.
rcokurt signature(object = "goGARCHfit") function:
rcokurt(object, standardize = TRUE, from = 1, to = 1)
Returns the 'time-varying' NxN^3 cokurtosis tensor in array format. The “from” and “to”
options indicate the time indices for which to return the arrays. Because of memory issues,
this is limited to models with less than 100 assets.

corv signature(object = "goGARCHfit"): Returns the time-varying NxN covariance matrix
in array format unless ‘output’ is set to “matrix” in which case the array is flattened and
the lower and main diagonal time varying values are returned (and if a date exists, then the
returned object is of class xts).

cor signature(object = "goGARCHfit"): Returns the time-varying NxN correlation matrix
in array format unless ‘output’ is set to “matrix” in which case the array is flattened and
the lower and main diagonal time varying values are returned (and if a date exists, then the
returned object is of class xts).

betacovar signature(object = "goGARCHfit"): function:
betacovar(object, weights, asset = 1, cluster = NULL)
Returns the covariance beta given a matrix (of length equal to the number of rows of the
original data, or vector which is then recycled to the number of rows of the original data) of
benchmark weights and the asset number.

betacoskew signature(object = "goGARCHfit"): function:
betacoskew(object, weights, asset = 1, cluster = NULL)
Returns the coskewness beta given a matrix (of length equal to the number of rows of the
original data, or vector which is then recycled to the number of rows of the original data) of
benchmark weights and the asset number.

betacokurt signature(object = "goGARCHfit"): function:
betacokurt(object, weights, asset = 1, cluster = NULL)
Returns the cokurtosis beta given a matrix (of length equal to the number of rows of the
original data, or vector which is then recycled to the number of rows of the original data) of
benchmark weights and the asset number.

show signature(object = "goGARCHfit"): Summary method.

Note
The reference by Paolella (2007) contains more details on the algorithm for the characteristic func-
tion inversion via FFT. The application of this method in a related model can be found in Chen
(2007). The de Athayde and Flores (2002) paper is the basis for the geometric properties of the
higher moment tensors in finance.

Author(s)
Alexios Ghalanos

References
with Higher Moments, mimeo.
Examples

```r
## Not run:
data(dji30ret)
spec = gogarchspec(mean.model = list(demean = "constant"),
  variance.model = list(model = "sGARCH", garchOrder = c(1,1), submodel = NULL),
  distribution.model = list(distribution = "manig", ica = "fastica")
fit = gogarchfit(spec = spec, data = dji30ret[,1:4], drop = FALSE),
  out.sample = 50, gfun = "tanh")
# The likelihood of the model
likelihood(fit)
# the GARCH coefficients of the independent factors
dep(fit)
# a news-impact surface plot
#ni = nisurface(fit, type = "cov", pair = c(1, 2), factor = c(1,2), plot = TRUE)
# the time varying correlation array
mc = rcor(fit)
# plot(mci[,2,], type = "l")
# The moments of an equally weighted portfolio (subtract the out.sample from dimension)
gm = gportmoments(fit, weights = matrix(1/4, ncol = 4,
  nrow = dim(dji30ret)[1]-50), debug = TRUE)
```

## End(Not run)

gogarchfit-methods function: GO-GARCH Filter

Description

Method for filtering the GO-GARCH model.

Usage

```r
gogarchfit(spec, data, out.sample = 0, solver = "solnp",
  fit.control = list(stationarity = 1), solver.control = list(), cluster = NULL,
  VAR.fit = NULL, ARcoef = NULL, ...)
``` 

Arguments

- `spec`: A GO-GARCH spec object of class goGARCHspec.
- `data`: A multivariate data object. Can be a matrix or data.frame or timeSeries.
- `out.sample`: A positive integer indicating the number of periods before the last to keep for out of sample forecasting.
solver          One of either “nlminb”, “solnp” or “gosolnp”.
solver.control Control arguments list passed to optimizer.
fit.control     Control arguments passed to the fitting routine. Stationarity explicitly imposes the variance stationarity constraint during optimization.
cluster         A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).
VAR.fit         (optional) A previously estimated VAR list returned from calling the `varxfilter` function.
ARcoef          An optional named matrix of the fitted AR parameters obtained from calling the `arfimafit` function on each series and then extracting the coefficients (the normal distribution should be used for the AR estimation). The number of columns should be equal to the number of series, and the rows should include the AR coefficients (common lag for all series), ‘sigma’, and if included the mean (‘mu’). The option to pass the coefficients directly rather than letting the function estimate them may be useful for example when there are convergence problems in the arfima routine and user control of each series estimation is desirable.

... Additional arguments passed to the ICA functions.

Value
A `gogarchfit` object containing details of the GO-GARCH fit.

Note
There is no check on the VAR.fit list passed to the method so particular care should be exercised so that the same data used in the fitting routine is also used in the VAR filter routine. The ability to pass this list of the pre-calculated VAR model is particularly useful when comparing different models (such as copula GARCH, DCC GARCH etc) using the same dataset and VAR method. Though the classical VAR estimation is very fast and may not require this extra step, the robust method is slow and therefore benefits from calculating this only once.

Author(s)
Alexios Ghalanos

Examples
```r
## Not run:
data(dji30ret)
spec = gogarchspec(mean.model = list(demean = "constant"),
                   variance.model = list(model = "sGARCH", garchOrder = c(1,1), submodel = NULL),
                   distribution.model = list(distribution = "manig"), ica = "fastica")

fit = gogarchfit(spec = spec, data = dji30ret[,1:4, drop = FALSE],
                 out.sample = 50, gfun = "tanh")
fit

## End(Not run)
```
goGARCHforecast-class

class: GO-GARCH Forecast Class

Description

Class for the GO-GARCH forecast.

Objects from the Class

The class is returned by calling the function gogarchforecast.

Slots

mforecast: Multivariate forecast object.
model: Object of class "vector" containing details of the GOGARCH model specification.

Extends

Class "mGARCHforecast", directly. Class "GARCHforecast", by class "mGARCHforecast", distance 2. Class "rGARCH", by class "mGARCHforecast", distance 3.

Methods

convolution signature(object = "goGARCHforecast"):

function:
  convolution(object, weights, fft.step = 0.001, fft.by = 0.0001, fft.support = c(-1, 1), support.method = c("user", "adaptive"), use.ff = TRUE, cluster = NULL, trace = 0,...)

The convolution method takes a goGARCHForecast object and a weights vector or matrix and calculates the weighted density. If a vector is given, it must be the same length as the number of assets, otherwise a matrix with row dimension equal to the total forecast horizon. In the case of the multivariate normal distribution, this simply returns the linear and quadratic transformation of the mean and covariance matrix, while in the multivariate affine NIG distribution this is based on the numerical inversion by FFT of the characteristic function. In that case, the “fft.step” option determines the stepsize for tuning the characteristic function inversion, “fft.by” determines the resolution for the equally spaced support given by “fft.support”, while the use of the “ff” package is recommended to avoid memory problems on some systems and is turned on via the “use.ff” option. The “support.method” option allows either a fixed support range to be given (option ‘user’), else an adaptive method is used based on the min and max of the assets at each point in time at the 0.00001 and 1-0.00001 quantiles. The range is equally spaced subject to the “fft.by” value but the returned object no longer makes of the “ff” package returning instead a list. The option for parallel computation is available via the use of a cluster object as elsewhere in this package. There is no special treatment of the forecast type here (unconditional or rolling), since either n.ahead with no roll or rolling with 1-ahead only choices are available for the gogarchforecast method. This means that the stored object does not distinguish between an unconditional or rolling forecast, calculating the density for all points (see note).
gportmoments signature(object = "goGARCHforecast"):
  function:
  gportmoments(object, weights)
  Calculates the first 4 standardized portfolio moments using the geometric properties of the
  model, given a matrix of asset weights with row dimension equal to the forecast n.ahead or
  n.roll horizon. Returns an array of dimensions n.ahead x 4 (moments) x n.roll, with the third
  array dimension labelled with the T+0 index times. If the number of assets > 100, then the
  kurtosis is not returned (see cokurtosis restrictions below).

rcoskew signature(object = "goGARCHforecast"):
  function:
  rcoskew(object, standardize = TRUE, from = 1, to = 1, roll = 0)
  Returns the 'time-varying' NxN^2 (coskewness tensor) x (to:fromroll) in array format. The
  “from” and “to” options indicate the time indices for which to return the array and “roll” the
  rolling index (base=0). The third dimension array label denotes the T+i (i=from:to) forecast
  horizon given the T+0 roll index which is returned as an attribute (attr(,"T+0")). The
  “standardize” option indicates whether the coskewness should be standardized by the
  conditional sigma (see equations in vignette). It is also possible to set roll to the character ‘all’
  in which case all the rolling 1-ahead forecasts are returned in an n by n^2 by (n.roll+1) array
  with 3rd dimension label the T+0 dates (instead of being an attribute).

rcokurt signature(object = "goGARCHforecast"):
  function:
  rcokurt(object, standardize = TRUE, from = 1, to = 1, roll = 0)
  Returns the 'time-varying' NxN^3 (cokurtosis tensor) x (to:fromroll) in array format. The
  “from” and “to” options indicate the time indices for which to return the array and “roll” the
  rolling index (base=0). Because of memory issues, this is only returned when the number of
  assets are less than 100. The third dimension array label denotes the T+i (i=from:to) forecast
  horizon given the T+0 roll index which is returned as an attribute (attr(,"T+0")). The
  “standardize” option indicates whether the cokurtosis should be standardized by the con-
  ditional sigma (see equations in vignette). It is also possible to set roll to the character ‘all’
  in which case all the rolling 1-ahead forecasts are returned in an n by n^3 by (n.roll+1) array
  with 3rd dimension label the T+0 dates (instead of being an attribute).

rcov signature(object = "goGARCHforecast"):
  Returns the conditional covariances, in a list
  of length (n.roll+1), with names the T+0 index, and each list slot having an array of dimensions
  n.asset x n.asset x n.ahead, with the third array dimension labelled as T+i (i>0). A further
  argument ‘output’ allows to switch between “array” and “matrix” returned object.

rcor signature(object = "goGARCHforecast"):
  Returns the conditional correlations, in a list
  of length (n.roll+1), with names the T+0 index, and each list slot having an array of dimensions
  n.asset x n.asset x n.ahead, with the third array dimension labelled as T+i (i>0). A further
  argument ‘output’ allows to switch between “array” and “matrix” returned object.

coef signature(object = "goGARCHforecast"):
  Extraction of independent factor GARCH
  model coefficients saved from the goGARCHfit object.

fitted signature(object = "goGARCHforecast"):
  Extracts the conditional mean forecast val-
  ues. Returns an n.ahead x n.assets x (n.roll+1) array where the third dimension array labels
  are the T+0 index times.

sigma signature(object = "goGARCHforecast"):
  Extracts the conditional sigma forecast val-
  ues. Returns an n.ahead x n.assets x (n.roll+1) array where the third dimension array labels
are the T+0 index times. Takes optional argument “factors” (default TRUE) denoting whether to return the factor conditional sigma or the transformed sigma for the assets.

\textbf{as.matrix} signature(x = "goGARCHforecast"): function: 
\textbf{as.matrix}(x, which = "A")
This returns four types of matrices relating to the estimation of the independent components in the GO-GARCH model. Valid choices are “A” for the mixing matrix, “W” for the unmixing matrix, “U” for the rotational matrix and “K” for the whitening matrix, “Kinv” for the de-whitening matrix.

\textbf{betacovar} signature(object = "goGARCHforecast"): function: 
\textbf{betacovar}(object, weights, asset = 1)
Returns the covariance beta given a matrix (of length equal to the number of rows of the forecast horizon, or vector which is then recycled to the number of rows of the forecast horizon) of benchmark weights and the asset number.

\textbf{betacoskew} signature(object = "goGARCHforecast"): function: 
\textbf{betacoskew}(object, weights, asset = 1)
Returns the coskewness beta given a matrix (of length equal to the number of rows of the forecast horizon, or vector which is then recycled to the number of rows of the forecast horizon) of benchmark weights and the asset number.

\textbf{betacokurt} signature(object = "goGARCHforecast"): function: 
\textbf{betacokurt}(object, weights, asset = 1)
Returns the cokurtosis beta given a matrix (of length equal to the number of rows of the forecast horizon, or vector which is then recycled to the number of rows of the forecast horizon) of benchmark weights and the asset number.

\textbf{show} signature(object = "goGARCHforecast"): Summary method.

\textbf{Note}


Forecasts are carried out on the time varying parameters of the factor distributions, and then scaled and transformed to those of the assets after adding back the mean forecast (which is either a constant or the AR/VAR mean forecast).

\textbf{Author(s)}

Alexios Ghalanos

\textbf{References}


---

**gogarchforecast-methods**

*function: GO-GARCH Forecast*

**Description**

Method for forecasting from the GO-GARCH model.

**Usage**

```r
gogarchforecast(fit, n.ahead = 10, n.roll = 0, 
external.forecasts = list(mregfor = NULL), cluster = NULL, ...)
```

**Arguments**

- `fit` A GO-GARCH fit object of class `gogARCHfit`.
- `n.ahead` The forecast horizon.
- `n.roll` The no. of rolling forecasts to create beyond the first one.
- `external.forecasts` A list with a matrix object of the external lagged forecasts (if used). These must contain (n.roll+1) x n.ahead forecasts.
- `cluster` A cluster object created by calling `makeCluster` from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).

**Value**

A `gogARCHforecast` object containing details of the GO-GARCH forecast.

**Author(s)**

Alexios Ghalanos

**Examples**

```r
## Not run:
data(dji30ret)
spec = gogarchspec()
fit = gogarchfit(spec = spec, data = dji30ret[,1:4], out.sample = 10,
gfun = "tanh")
forecast = gogarchforecast(fit, n.ahead = 1, n.roll = 9)

## End(Not run)
```
**goGARCHroll-class**  

class: GO-GARCH Roll Class

---

**Description**

Class for the GO-GARCH Roll.

**Objects from the Class**

The class is returned by calling the function `gogarchroll`.

**Slots**

- **forecast**: Object of class "vector" which contains the rolling forecasts of the distributional parameters for each factor.
- **model**: Object of class "vector" containing details of the GOGARCH model specification.

**Extends**

Class "mGARCHroll", directly. Class "GARCHroll", by class "mGARCHroll", distance 2. Class "rGARCH", by class "mGARCHroll", distance 3.

**Methods**

- **coef** signature(object = "goGARCHroll"): Extraction of independent factor GARCH model coefficients saved from the goGARCHfit objects (returns a list).
- **fitted** signature(object = "goGARCHroll"): Extracts the conditional fitted forecast values (returns an xts object with index the actual forecast T+1 times).
- **sigma** signature(object = "goGARCHroll"): Extracts the conditional sigma forecast values (returns an xts object with index the actual forecast T+1 times). Takes optional argument "factors" (default TRUE) denoting whether to return the factor conditional sigma or the transformed sigma for the assets.
- **rcov** signature(object = "goGARCHroll"): Returns the time-varying n.asset x n.asset x (n.roll+1) covariance matrix in array format, where the third dimension labels are now the actual rolling n.ahead=1 forecast time indices (T+1). A further argument 'output' allows to switch between “array” and “matrix” returned object.
- **rcor** signature(object = "goGARCHroll"): Returns the time-varying n.asset x n.asset x (n.roll+1) correlation matrix in array format, where the third dimension labels are now the actual rolling n.ahead=1 forecast time indices (T+1). A further argument 'output' allows to switch between “array” and “matrix” returned object.
- **rcoskew** signature(object = "goGARCHroll"): Returns the time-varying n.asset x n.asset^2 x (n.roll+1) coskewness matrix in array format, where the third dimension labels are now the actual rolling n.ahead=1 forecast time indices (T+1). There is a “standardize” option which indicates whether the coskewness should be standardized by the conditional sigma (see equations in vignette).
**rcokurt** signature(object = "goGARCHroll"): Returns the time-varying n.asset x n.asset^3 x (n.roll+1) cokurtosis matrix in array format, where the third dimension labels are now the actual rolling n.ahead=1 forecast time indices (T+1). There is a “standardize” option which indicates whether the cokurtosis should be standardized by the conditional sigma (see equations in vignette).

**gportmoments** signature(object = "goGARCHroll"):
function:

gportmoments(object, weights)
Calculates the first 4 standardized portfolio moments using the geometric properties of the model, given a matrix of asset weights with row dimension equal to the total rolling forecast horizon. Returns an xts object of dimensions (total rolling forecast) x 4 (moments), with the index denoting the T+1 actual forecast time. If the number of assets > 100, then the kurtosis is not returned (see cokurtosis restrictions below).

**convolution** signature(object = "goGARCHroll"):
function:

convolution(object, weights, fft.step = 0.001, fft.by = 0.0001, fft.support = c(-1, 1), support.method = c("user", "adaptive"), use.ff = TRUE, cluster = NULL, trace = 0,...)
The convolution method takes a goGARCHRoll object and a weights vector or matrix and calculates the weighted density. If a vector is given, it must be the same length as the number of assets, otherwise a matrix with row dimension equal to the row dimension of total forecast horizon. In the case of the multivariate normal distribution, this simply returns the linear and quadratic transformation of the mean and covariance matrix, while in the multivariate affine NIG distribution this is based on the numerical inversion by FFT of the characteristic function. In that case, the “fft.step” option determines the stepsize for tuning the characteristic function inversion, “fft.by” determines the resolution for the equally spaced support given by “fft.support”, while the use of the “ff” package is recommended to avoid memory problems on some systems and is turned on via the “use.ff” option. The “support.method” option allows either a fixed support range to be given (option ‘user’), else an adaptive method is used based on the min and max of the assets at each point in time at the 0.00001 and 1-0.00001 quantiles. The range is equally spaced subject to the “fft.by” value but the returned object no longer makes of the “ff” package returning instead a list. The option for parallel computation is available via the use of a cluster object as elsewhere in this package. Passing this object to the distribution methods (e.g. qfft) follows the same rules as the goGARCHforecast object, namely that the index is zero based.

**show** signature(object = "goGARCHroll"): Summary.

**Author(s)**
Alexios Ghalanos
Usage

gogarchroll(spec, data, n.ahead = 1, forecast.length = 50, n.start = NULL, refit.every = 25, refit.window = c("recursive", "moving"), window.size = NULL, solver = "solnp", solver.control = list(), fit.control = list(), rseed = NULL, cluster = NULL, save.fit = FALSE, save.wdir = NULL, ...)

Arguments

spec A GO-GARCH spec object of class goGARCHspec.
data A multivariate data object. Can be a matrix or data.frame or timeSeries.
n.ahead The forecast horizon (only 1-ahead supported for rolling forecasts).
forecast.length The length of the total forecast for which out of sample data from the dataset will be excluded for testing.
n.start Instead of forecast.length, this determines the starting point in the dataset from which to initialize the rolling forecast.
refit.every Determines every how many periods the model is re-estimated.
refit.window Whether the refit is done on an expanding window including all the previous data or a moving window where all previous data is used for the first estimation and then moved by a length equal to refit.every (unless the window.size option is used instead).
window.size If not NULL, determines the size of the moving window in the rolling estimation, which also determines the first point used.
solver The solver to use.
fit.control Control parameters parameters passed to the fitting function.
solver.control Control parameters passed to the solver.
rseed Initialization seed for first ICA fit. The rest of the ICA fits are initialized with the previous mixing matrix (using A.init).
cluster A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation (remember to stop the cluster on completion).
save.fit Whether to save the fitted objects of class goGARCHfit during the estimation of each ("refit.every"). If true, the directory to save must be provided (see below). The function will not save this by default for reasons of memory management, but can save it as an “.rda” file in the user’s chosen directory for further analysis.
save.wdir If “save.fit” is true, the directory in which to save the goGARCHfit objects (1 for each “refit.every”).

Value

An object of class goGARCHroll.

Author(s)

Alexios Ghalanos
goGARCHsim-class  

Description

Class for the GO-GARCH Simulation.

Objects from the Class

The class is returned by calling the function `gogarchsim`.

Slots

- `msim`: Object of class "vector" The multivariate simulation list.
- `model`: Object of class "vector" containing details of the GO-GARCH model specification.

Extends

Class "mGARCHsim", directly. Class "GARCHsim", by class "mGARCHsim", distance 2. Class "rGARCH", by class "mGARCHsim", distance 3.

Methods

- `convolution` signature(object = "goGARCHsim"):
  
  function:
  convolution(object, weights, fft.step = 0.001, fft.by = 0.0001, fft.support = c(-1, 1), support.method = c("user", "adaptive"), use.ff = TRUE, sim = 1, cluster = NULL, trace = 0,...)

  The convolution method takes a goGARCHsim object and a weights vector and calculates the weighted density. The vector must be the same length as the number of assets. The "sim" option indicates the simulation index to use, given the "m.sim" option chosen in the call to the simulation function. In the case of the multivariate normal distribution, this simply returns the linear and quadratic transformation of the mean and covariance matrix, while in the multivariate affine NIG distribution this is based on the numerical inversion by FFT of the characteristic function. In that case, the "fft.step" option determines the stepsize for tuning the characteristic function inversion, "fft.by" determines the resolution for the equally spaced support given by "fft.support", while the use of the "ff" package is recommended to avoid memory problems on some systems and is turned on via the "use.ff" option. The "support.method" option allows either a fixed support range to be given (option 'user'), else an adaptive method is used based on the min and max of the assets at each point in time at the 0.00001 and 1-0.00001 quantiles. The range is equally spaced subject to the "fft.by" value but the returned object no longer makes use of the "ff" package returning instead a list. Finally, the option for parallel computation is available via the use of a cluster object as elsewhere in this package.

- `gportmoments` signature(object = "goGARCHsim"):
  
  function:
  gportmoments(object, weights, sim = 1)

  Calculates the first 3 portfolio moments using the geometric properties of the model, given a
matrix of asset weights with row dimension equal to the row dimension of the filtered dataset (i.e. less any lags). The “sim” option indicates the simulation index to use, given the “m.sim” option chosen in the call to the simulation function.

**rcoskew** signature(object = "goGARCHsim"):

function:

rcoskew(object, from = 1, to = 1, sim = 1)

Returns the 'time-varying' NxN^2 coskewness tensor in array format. The “from” and “to” options indicate the time indices for which to return the arrays. Because of memory issues, this is limited to 100 indices. The “sim” option indicates the simulation index to use, given the “m.sim” option chosen in the call to the simulation function.

**rcokurt** signature(object = "goGARCHsim"):

function:

rcokurt(object, standardize = TRUE, from = 1, to = 1)

Returns the 'time-varying' NxN^3 cokurtosis tensor in array format. The “from” and “to” options indicate the time indices for which to return the arrays. Because of memory issues, this is limited to models with less than 20 assets.

**rcov** signature(object = "goGARCHsim"):

Returns the time-varying NxN covariance matrix in array format. There is an additional “sim” option which indicates the simulation index to use, given the “m.sim” option chosen in the call to the simulation function. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

**rcor** signature(object = "goGARCHsim"):

Returns the time-varying NxN correlation matrix in array format. There is an additional “sim” option which indicates the simulation index to use, given the “m.sim” option chosen in the call to the simulation function. A further argument ‘output’ allows to switch between “array” and “matrix” returned object.

**as.matrix** signature(x = "goGARCHsim"):

function:

as.matrix(x, which = "A")

This returns four types of matrices relating to the estimation of the independent components in the GO-GARCH model. Valid choices are “A” for the mixing matrix, “W” for the unmixing matrix, “U” for the rotational matrix and “K” for the whitening matrix, “Kinv” for the de-whitening matrix.

**Author(s)**

Alexios Ghalanos
Usage

gogarchsim(object, n.sim = 1, n.start = 0, m.sim = 1,
    startMethod = c("unconditional", "sample"), prereturns = NA, preresiduals = NA,
    presigma = NA, mexsimdata = NULL, rseed = NULL, cluster = NULL, ...)

Arguments

object A GO-GARCH fit object of class goGARCHfit or goGARCHfilter.
n.sim The simulation horizon.
n.start The burn-in sample.
m.sim The number of simulations.
startMethod Starting values for the simulation. Valid methods are “unconditional” for the
    expected values given the density, and “sample” for the ending values of the
    actual data from the fit object.
prereturns Allows the starting return data to be provided by the user.
preresiduals Allows the starting factor residuals to be provided by the user.
presigma Allows the starting conditional factor sigma to be provided by the user.
mexsimdata A list of matrices with the simulated lagged external variables (if any). The list
    should be of size m.sim and the matrices each have n.sim + n.start rows.
rseed Optional seeding value(s) for the random number generator.
cluster A cluster object created by calling makeCluster from the parallel package. If
    it is not NULL, then this will be used for parallel estimation (remember to stop
    the cluster on completion).
...

Value

A goGARCHsim object containing details of the GO-GARCH simulation.

Author(s)

Alexios Ghalanos

description

class: GO-GARCH Specification Class

Objects from the Class

The class is returned by calling the function goGARCHspec.
Slots

  model: Multivariate model specification.
  umodel: Univariate model specification.

Extends

  Class "mGARCHspec", directly. Class "GARCHspec", by class "mGARCHspec", distance 2. Class
  "rGARCH", by class "mGARCHspec", distance 3.

Methods

  show signature(object = "goGARCHspec"): Summary method.

Note

  The mixing matrix in the GO-GARCH model implemented in the rmgarch package is based on
  non-parametric independent component analysis (ICA) methodology. The estimation is a 2-stage
  methodology described in Broda and Paolella (2009) and Zhang and Chan (2009). The extension
to the use of the full multivariate affine GH distribution is detailed in Ghalanos et al (2011).

Author(s)

  Alexios Ghalanos

References

  of Applied Econometrics, 549–564.
  Zhang, K. and Chan, L. 2009, Efficient factor GARCH models and factor-DCC models, Quantitative
  Finance, 71–91.
  Density Model, Pending–submitted.
Usage

gogarchspec(mean.model = list(model = c("constant", "AR", "VAR"), robust = FALSE, lag = 1, lag.max = NULL, lag.criterion = c("AIC", "HQ", "SC", "FPE"), external.regressors = NULL, robust.control = list("gamma" = 0.25, "delta" = 0.01, "nc" = 10, "ns" = 500)), variance.model = list(model = "sGARCH", garchOrder = c(1,1), submodel = NULL, variance.targeting = FALSE), distribution.model = c("mvnorm", "manig", "magh"), ica = c("fastica", "radical"), ica.fix = list(A = NULL, K = NULL), ...) 

Arguments

mean.model The mean specification. Allows for either a constant filtration of the return series, a univariate AR for each series with common lag (via the “lag” argument) else a classical or robust Vector Autoregressive Model (VAR). The ‘robust’ option allows for a robust version of VAR based on the multivariate Least Trimmed Squares Estimator described in Croux and Joossens (2008). The ‘robust.control’ includes additional tuning parameters to the robust regression including the proportion to trim (“gamma”), the critical value for Reweighted estimator (“delta”), the number of subsets (“ns”) and the number of C-steps (“nc”). The external.regressors argument allows for a matrix of common external regressors in the constant, AR or VAR formulations.

variance.model The univariate variance specification for the independent factors of the GO-GARCH model.

distribution.model The distributions supported are the multivariate normal (“mvnorm”) and the multivariate affine NIG (“manig”) and GHYP (“magh”) distributions of Schmidt et al (see references).

ica The algorithm to use for extracting the independent components. The fastica and radical algorithms are the only ICA algorithms currently allowed and locally implemented. See their documentation for a list of additional arguments possible, which may be passed in the gogarchfit method.

ica.fix This allows the option of supplying the mixing matrix (A) and optionally the whitening Matrix (K). This is likely to be use when comparing different models (with the same mean filtration and dataset but different variance models) and you wish to use the same independent factors.

Value

A goGARCHspec object containing details of the GO-GARCH specification.

Author(s)

Alexios Ghalanos
**goload-methods**

**Load Scenario from File**

**Description**

 Loads a previously saved fScenario from file and returns a fScenario or fMoments object.

**Usage**

    goload(object, ...)

**Arguments**

- **object** A fScenario or fMoments object which was created with save.output set to TRUE.
- **...** not used.

**Details**

 There are times when it is more efficient to save large scenarios to file (particularly when creating them in parallel), rather than returning them to the user workspace. The save.output option in the fScenario and fMoments allows to do just that, returning instead a lighter object with an empty scenario slot, but with the model slot included, containing the details of the location and name of the saved scenario (or moments list). The goload function then takes this object, reads the location and name and loads the scenario (or moments) into its slot in the object and returns this to the user’s workspace.

**Value**

 A fScenario or fMoments object with the scenario or moments slot now filled with the saved data from file.

**Author(s)**

 Alexios Ghalanos

---

**last-methods**

**First and Last methods for accessing objects**

**Description**

 Functions for accessing first-n and last-n values of an object (similar to head and tail).
Usage

last(x, index = 1, ...)  
first(x, index = 1, ...)  

Arguments

x  
Currently only arrays supported.  
index  
First or Last n-indices to return values for.  
...  
For expansion to other classes.  

Methods

signature(x = "ANY")  
signature(x = "array")  

Author(s)

Alexios Ghalanos
mGARCHfit-class

Class: Multivariate GARCH Fit Class

Description
High Level multivariate GARCH fit class.

Objects from the Class
A virtual Class: No objects may be created from it.

Extends
Class "GARCHfit", directly. Class "rGARCH", by class "GARCHfit", distance 2.

Methods
No methods defined with class "mGARCHfit" in the signature.

Author(s)
Alexios Ghalanos

mGARCHforecast-class

Class: Multivariate GARCH Forecast Class

Description
High Level multivariate GARCH forecast class.

Objects from the Class
A virtual Class: No objects may be created from it.

Extends
Class "GARCHforecast", directly. Class "rGARCH", by class "GARCHforecast", distance 2.

Methods
No methods defined with class "mGARCHforecast" in the signature.

Author(s)
Alexios Ghalanos
mGARCHsim-class

Class: Multivariate GARCH Simulation Class

Description
High Level multivariate GARCH simulation class.

Objects from the Class
A virtual Class: No objects may be created from it.

Extends
Class "GARCHsim", directly. Class "rGARCH", by class "GARCHsim", distance 2.

Methods
No methods defined with class "mGARCHsim" in the signature.

Author(s)
Alexios Ghalanos

mGARCHroll-class

Class: Multivariate GARCH Roll Class

Description
High Level multivariate GARCH roll class.

Objects from the Class
A virtual Class: No objects may be created from it.

Extends
Class "GARCHroll", directly. Class "rGARCH", by class "GARCHroll", distance 2.

Methods
No methods defined with class "mGARCHroll" in the signature.

Author(s)
Alexios Ghalanos
mGARCHspec-class

Class: Multivariate GARCH Specification

Description
High Level multivariate GARCH specification class.

Objects from the Class
A virtual Class: No objects may be created from it.

Extends
Class "GARCHspec", directly. Class "rGARCH", by class "GARCHspec", distance 2.

Methods
No methods defined with class "mGARCHspec" in the signature.

Author(s)
Alexios Ghalanos

radical

The Robust Accurate, Direct ICA Algorithm (RADICAL).

Description
An ICA algorithm based on an efficient entropy estimator (due to Vasicek) which is robust to outliers.

Usage
```r
radical(X, n.comp = dim(X)[2], demean = TRUE, pca.cov = c("ML", "LW", "ROB", "EWMA"),
k = 150, augment = FALSE, replications = 30, sd = 0.175, firstEig = 1,
lastEig = dim(X)[1], pcaE = NULL, pcaD = NULL, whiteSig = NULL, whiteMat = NULL,
dewhiteMat = NULL, rseed = NULL, trace = FALSE, ...)
```
Arguments

- **X**  
  The multidimensional signal matrix, where each column of matrix represents one observed signal.

- **n.comp**  
  Number of independent components to estimate, defaults to the dimension of the data (rows). Is overwritten by `firstEig` and `lastEig`.

- **demean**  
  (Logical) Whether the data should be centered.

- **pca.cov**  
  The method to use for the calculation of the covariance matrix during the PCA whitening phase. “ML” is the standard maximum likelihood method, “LW” is the Ledoit-Wolf method, “ROB” is the robust method from the MASS package and “EWMA” an exponentially weighted moving average estimator. Optional parameters passed via the … argument.

- **k**  
  The number of angles at which to evaluate the contrast function. The ICA contrast function will be evaluated at K evenly spaced rotations from -Pi/4 to Pi/4.

- **augment**  
  Whether to augment the data (as explained in paper). For large datasets of >10,000 points this should be set to FALSE.

- **replications**  
  This is the number of replicated points for each original point. The default value is 30. The larger the number of points in the data set, the smaller this value can be. For data sets of 10,000 points or more, point replication should be deactivated by setting augment to FALSE.

- **sd**  
  This is the standard deviation (noise) of the replicated points when using the augmentation option.

- **firstEig**  
  This and `lastEig` specify the range for eigenvalues that are retained, `firstEig` is the index of largest eigenvalue to be retained. Making use of this option overwrites `n.comp`.

- **lastEig**  
  This is the index of the last (smallest) eigenvalue to be retained and overwrites `n.comp` argument.

- **pcaE**  
  Optionally provided eigenvector (must also supply `pcaD`).

- **pcaD**  
  Optionally provided eigenvalues (must also supply `pcaE`).

- **whiteSig**  
  Optionally provided Whitened signal.

- **whiteMat**  
  Optionally provided Whitening matrix (no.factors by no.signals).

- **dewhiteMat**  
  Optionally provided dwhitening matrix (no.signals by no.factors).

- **rseed**  
  Optionally provided seed to initialize the augmented data matrix.

- **trace**  
  To report progress in the console, set this to TRUE.

- **...**  
  Optional arguments passed to the `pca.cov` methods.

Details

The interested reader should consult the paper in the references section for details on the properties of the algorithm.

The algorithm is quite slow, despite partial implementation in C++, and should only be used on small to medium sized sets.
Value

A list containing the following values:

- **A**: Estimated Mixing Matrix (no.signals by no.factors).
- **W**: Estimated UnMixing Matrix (no.factors by no.signals).
- **U**: Estimated rotation Matrix (no.factors by no.factors).
- **S**: The column vectors of estimated independent components (no.obs by no.factors).
- **C**: Estimated Covariance Matrix (no.signals by no.signals).

- **whiteningMatrix**: The Whitening matrix (no.factors by no.signals).
- **dewhitenningMatrix**: The de-Whitening matrix (no.signals by no.factors).
- **rseed**: The random seed used (if any) for initializing the mixing matrix A.
- **elapsed**: The elapsed time.

Author(s)

Erik G. Learned-Miller for the Radical algorithm and Matlab package.
Alexios Ghalanos for this R-port.

References


Examples

```r
## Not run:
# create a set of independent signals S, glued together by a mixing matrix A
# (note the notation and matrix multiplication direction as we are dealing with
# row rather than column vectors)
set.seed(100)
S <- matrix(runif(10000), 5000, 2)
A <- matrix(c(1, 1, -1, 2), 2, 2, byrow = TRUE)
# the mixed signal X
X <- S %*% t(A)
# The function centers and whitens (by the eigenvalue decomposition of the
# unconditional covariance matrix) the data before applying the theICA algorithm.
IC <- radical(X, n.comp = 2)

# demeaned data:
X_bar = scale(X, scale = FALSE)

# whitened data:
X_white = X_bar %*% t(IC$whiteningMatrix)

# check whitening:
# check correlations are zero
```
cor(X_white)
# check diagonals are 1 in covariance
cov(X_white)

# check that the estimated signals(s) multiplied by the
# estimated mxing matrix (A) are the same as the original dataset (X)
round(head(IC$ %*% t(IC$A)), 12) == round(head(X), 12)

# do some plots:
par(mfrow = c(1, 3))
plot(IC$ %*% t(IC$A), main = "Pre-processed data")
plot(X_white, main = "Whitened and Centered components")
plot(IC$, main = "ICA components")

## End(Not run)

---

**varxfit**  
*VARX Fit/Filter/Forecast/Simulation Functions*

**Description**

Vector Autoregressive (VAR) with Constant and Optional Exogenous Regressors (X) Fit, Filter, Forecast and Simulation functions for use with multivariate GARCH models.

**Usage**

```r
varxfit(X, p, constant = TRUE, exogen = NULL, robust = FALSE, gamma = 0.25,
delta = 0.01, nc = 10, ns = 500, postpad = c("none", "constant", "zero", "NA"),
cluster = NULL)
varxfilter(X, p, Bcoef, exogen = NULL, postpad = c("none", "constant", "zero", "NA"))
varxforecast(X, Bcoef, p, outNsample, nAhead, nRoll, mregfor)
varxsim(X, Bcoef, p, nSim, nStart, prereturns, resids, mexsimdata)
```

**Arguments**

- **X** A multivariate data matrix.
- **p** The number of autoregressive lags.
- **constant** Whether to include a constant.
- **exogen** An optional matrix of exogenous regressors with as many rows as X, and appropriately lagged.
- **Bcoef** A matrix of coefficients for the varxfilter function.
- **robust** Whether to use the robust version of VAR based on the multivariate Least Trimmed Squares Estimator described in Croux and Joossens (2008).
- **gamma** Proportion to trim in the robust method.
- **delta** The critical value for Reweighted estimator for the robust method.
- **ns** The number of subsets to use for the robust method.
The number of C-steps to use for the robust method.

(postpad 'none') Whether to postpad the fitted/filtered values (and hence calculation of residuals) with the estimated constant, zeros or NA's, thus returning matrices of the same size as the input data (rather than input data size less the number of lags).

A cluster object created by calling makeCluster from the parallel package. If it is not NULL, then this will be used for parallel estimation in the case of the robust VAR version (remember to stop the cluster on completion).

The number of points kept for out of sample rolling forecast.

The forecast horizon.

In combination with `out.sample`, determines the number of times to roll forward the `n.ahead` forecast using data left out of sample.

Matrix of external regressor forecasts (with appropriate lag structure).

Simulation horizon.

Simulation burn-in sample.

Optionally supplied pre-return matrix with “p” lags to initialize simulation.

Matrix of randomly generated residuals of size `n.sim+n.start`.

Matrix of external regressor pre-generated random values to use in the simulation (if NULL then assumed zero).

This are convenience functions to be optionally used when using the multivariate GARCH methods.

A list with the following items:

- `bcoef` [varxfit, varxfilter]
  The coefficient matrix with rows equal to number of assets, and columns equal to number of assets x number of lags plus 1 (constant) plus number of exogenous regressors.

- `xfitted` [varxfit, varxfilter]
  The fitted/filtered series (conditional mean series).

- `xresiduals` [varxfit, varxfilter]
  The residuals.

- `bcov` [varxfit]
  The covariance matrix of the coefficients.

- `se` [varxfit]
  The standard error of the coefficients.

- `tstat` [varxfit]
  The t-stat of the s.e.
pstat
[varxfit]
The p-values of the s.e.

lag
[varxfit, varxfilter]
The number of autoregressive lags.

mxn
[varxfit]
The number of exogenous regressors.

meansim
[varxsim]
The simulated conditional mean.

The varxsim returns an n.sim x n.asset matrix of the simulated conditional means, while the varx-forecast returns an n.ahead x n.assets x (n.roll+1) array of the forecast conditional means.

Note
Part of the varxfit functionality and structure is inspired from the ‘vars’ package, but the estimation method is implemented in a very quick way without calling ‘lm’. The robust method is based on the matlab program of Christophe Croux available from his website and the option of using parallel computation is implemented for this particular choice. The postpad option is used when the returned data needs to be of the same size as the inputed data for easier manipulation/comparison (since padding is done post-estimation, there is no bias introduced during estimation).

Author(s)
Alexios Ghalanos

References

---

wmargin

Weighted Distribution Margin

Description
Return the weighted margin of one of 3 elliptical distributions given a matrix of weights.

Usage
wmargin(distribution = "mvnorm", weights, mean, Sigma, shape = NA, skew = NA)
Arguments

distribution   One of ‘mvnorm’, ‘mvlaplace’ or ‘mvt’.
weights        Either a vector or matrix of weights, in the latter case must be of the same row
dimension as the covariance array.
mean           With a vector or matrix of conditional distribution means, in the latter case
               must be of the same row dimension as the covariance array.
Sigma          An array of covariances, usually returned by calling the ‘rcov’ method on one
               of the multivariate GARCH fitted objects.
shape          The shape (d.o.f.) parameter of the multivariate student distribution.
skew           Not currently required for the 3 distributions used.

Details

This is just a convenience function to return the weighted variance and mean of the three elliptical
distributions given a set of weights.

Value

A matrix with each row representing the conditional weighted marginal density with corresponding
parameters.

Author(s)

Alexios Ghalanos
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